WATER WORKS AND SEWERAGE

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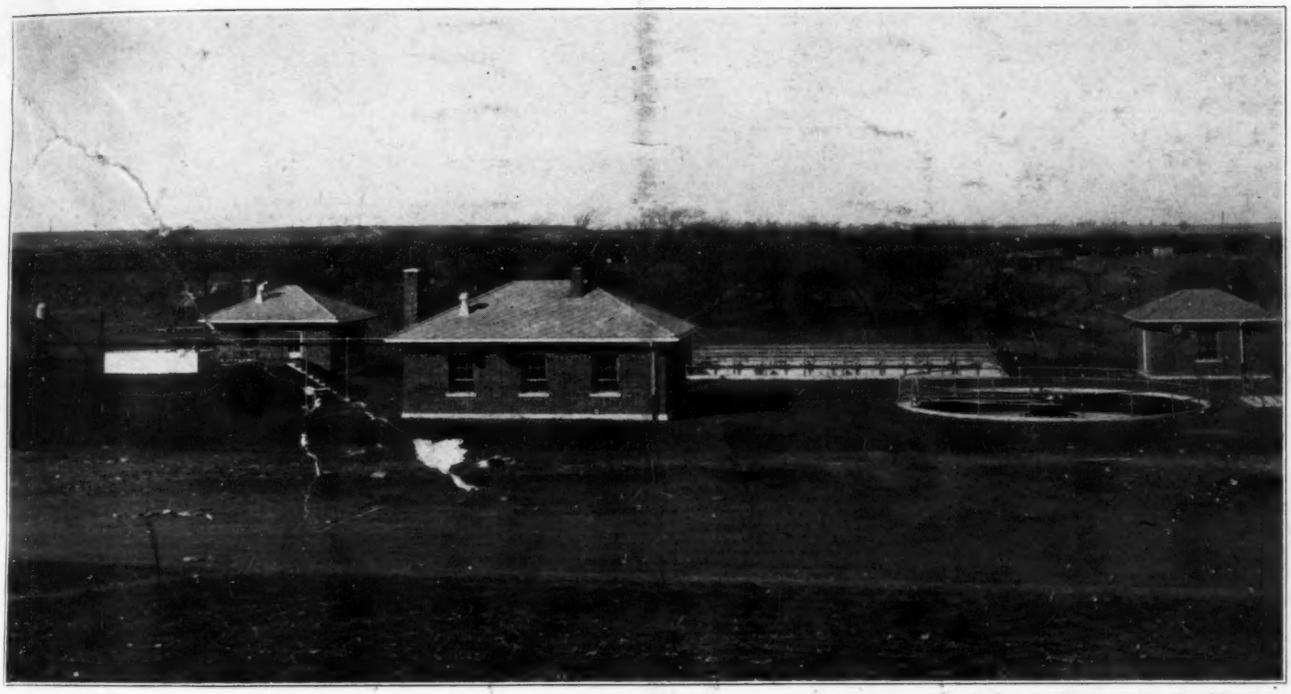
ebruary, 1934 Vol. LXXXI. No. 2



Sewage Treatment Plant, Herrington, Kan. (Black and Veach, Engineers). This Plant Just Completed Is to Be in a Large Measure Self-Supporting. The Rock Island Railroad Has Contracted to Take Effluent for Use in Locomotives and Shop Boilers.

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Handling Sugar Beet Wastes

What Is Super-De Lavand Pipe

A Dual Flow Compartment Meter

Results from the Use of Activated Alum at Batavia, N. Y.

Developments in Sewerage and Sewage Treatment During 1933

Report of Meeting of the New York State Sewage Works Association

Report of Meeting of the Sanitary Engineering Division of the Am. Soc. C. E.

THE technical staff of Guggenheim Brothers, after two years' intensive work, has developed a chemical process for the treatment of raw sewage. All putrescible matter is disposed of completely and effectively and the resulting effluent is of high purity.

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WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

Richard H. Ellis, Water Commissioner and Superintendent Water Works, Newton, Mass., will describe, what is believed to be, the most modernized and efficient meter shop arrangement and meter repair and maintenance practice in the East.

N. T. Veatch, Jr., Consulting Engineer, Kansas City, Mo., will discuss values to be recovered from "The Utilization of Sewage" and the by-products of sewage treatment. Of particular interest is the plant designed in Mr. Veatch's office for Herrington, Kansas, its financing being based on income from the sale of effluent for industrial usage by a railroad.

C. P. Hoover, Superintendent of Water Purification, Columbus, O., will describe a new installation for "Unloading, Handling and Feeding Soda Ash" in water softening practice.

C. E. Keefer, Engineer in Charge of Sewage Treatment, Baltimore, Md., will tell of the beneficial results procured from sludge recirculation from bottom to top of digesters.

L. C. Billings, Superintendent Filtration, Dallas, Texas, will relate his experiences with ferric iron coagulation involving the use of ferrous sulphate oxidized with chlorine—"chlorinated-copperas"—at Dallas.

W. L. Eisert, Manager, Riverton (Pa.) Consolidated Water Company, in his article—"Advertising"—recounts successful methods of advertising (in the broad sense) the local water utility and building good will thereby.

Dr. A. M. Buswell, Consulting Chemist, Urbana, Ill., will report the results of a "Thirty-Day Test Run Involving the Laughlin Process of Sewage Treatment" which was conducted under his direction at Dearborn, Mich.

A. S. Behrman, Chemical Director, International Filter Company, is to discuss modern methods and relate "Recent Developments in Municipal Water Softening."

S. T. Powell, Chemical Engineer, Baltimore, Md., writes on the "Corrosion of Water Well Casings by Electrolysis" and means of preventing such destruction.

Darwin W. Townsend, Consulting Engineer, Milwaukee Sewerage Commission, will contribute an article covering operating experiences and costs of centrifugal dewatering and incineration of screenings and grit at Milwaukee.

A. G. Nolte, and W. A. Kramer, Chief and Senior Chemical Engineers, St. Louis Water Department, will report on "Zinc and its Relation to Drinking Water," from the standpoint of solubility of galvanized linings of pipe and its relation to public health.

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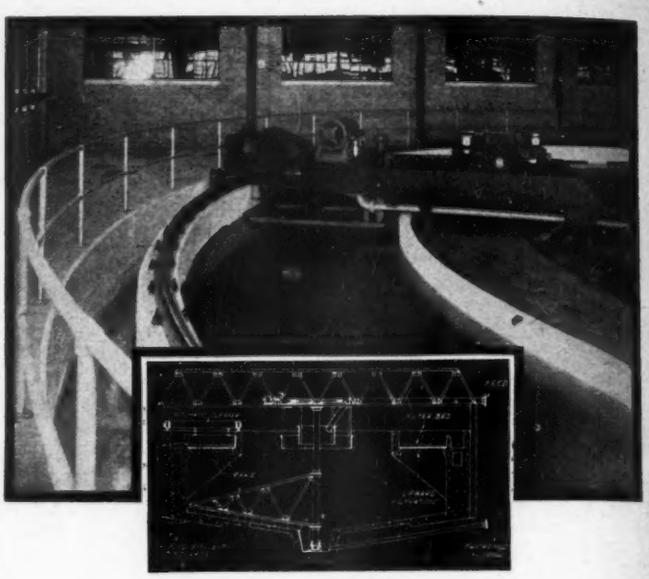

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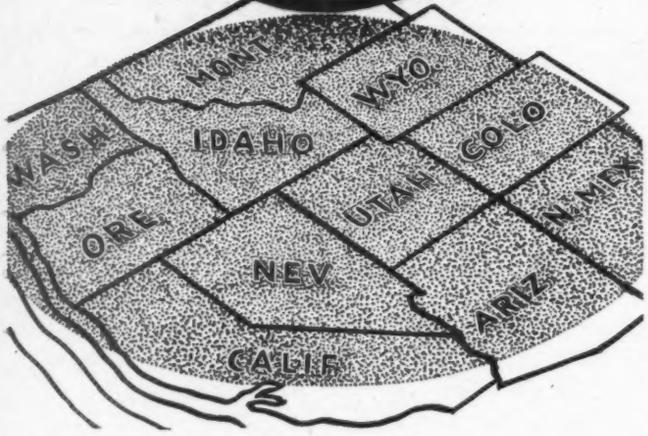

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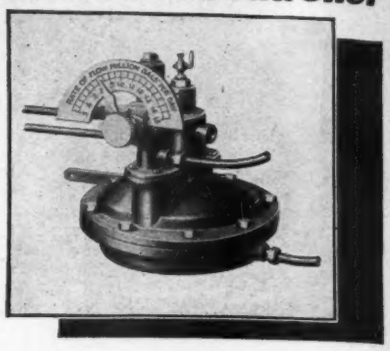

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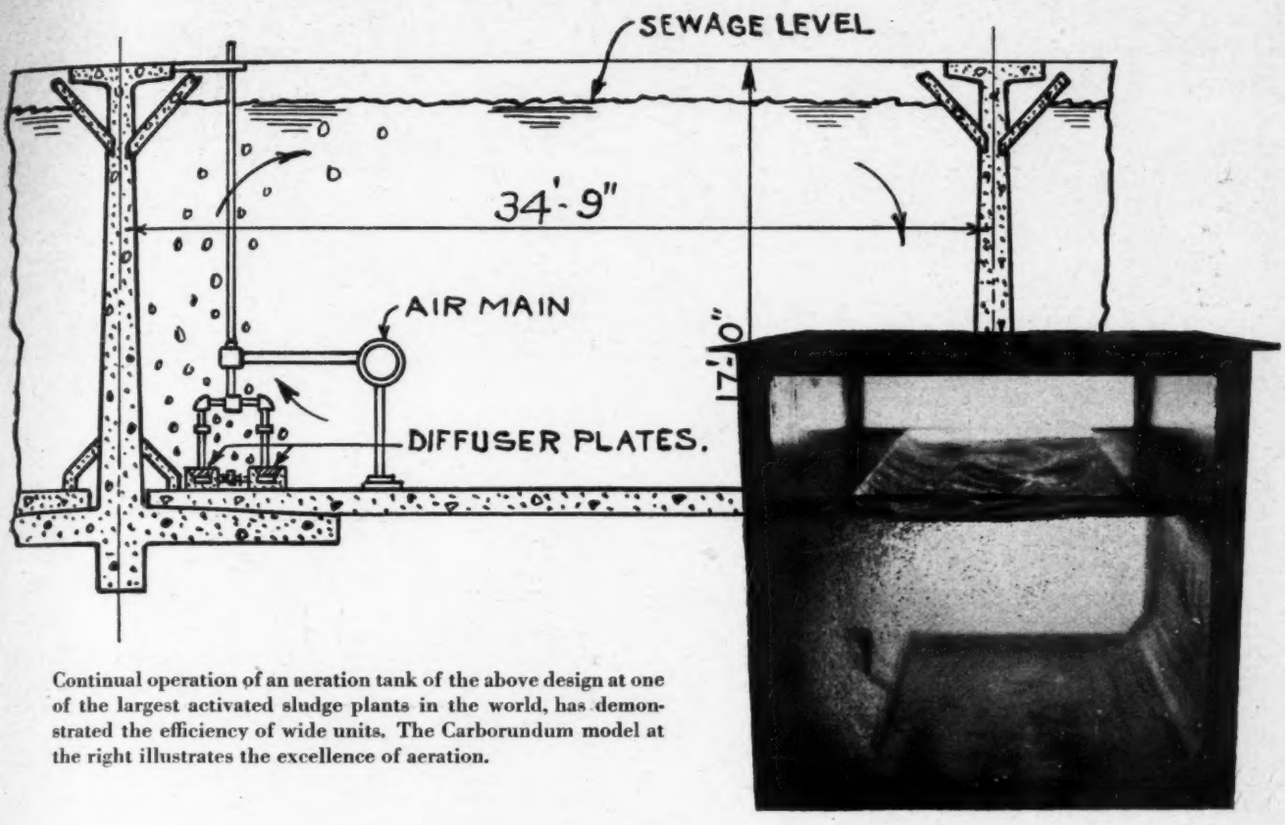
Forceful Facts on Sewage Aeration by Air Diffusion—No. 2



Continual operation of an aeration tank of the above design at one of the largest activated sludge plants in the world, has demonstrated the efficiency of wide units. The Carborundum model at the right illustrates the excellence of aeration.

—Design Improvements are Reducing Construction and Operation Costs of Complete Aeration Treatment

ANY number of examples can be listed to establish this fact. One of the most important is illustrated above. Wider tanks decrease (1) concrete quantities and other appurtenances per given tank volume, (2) diffuser area ratio and (3) volume of air required per gallon of sewage treated.

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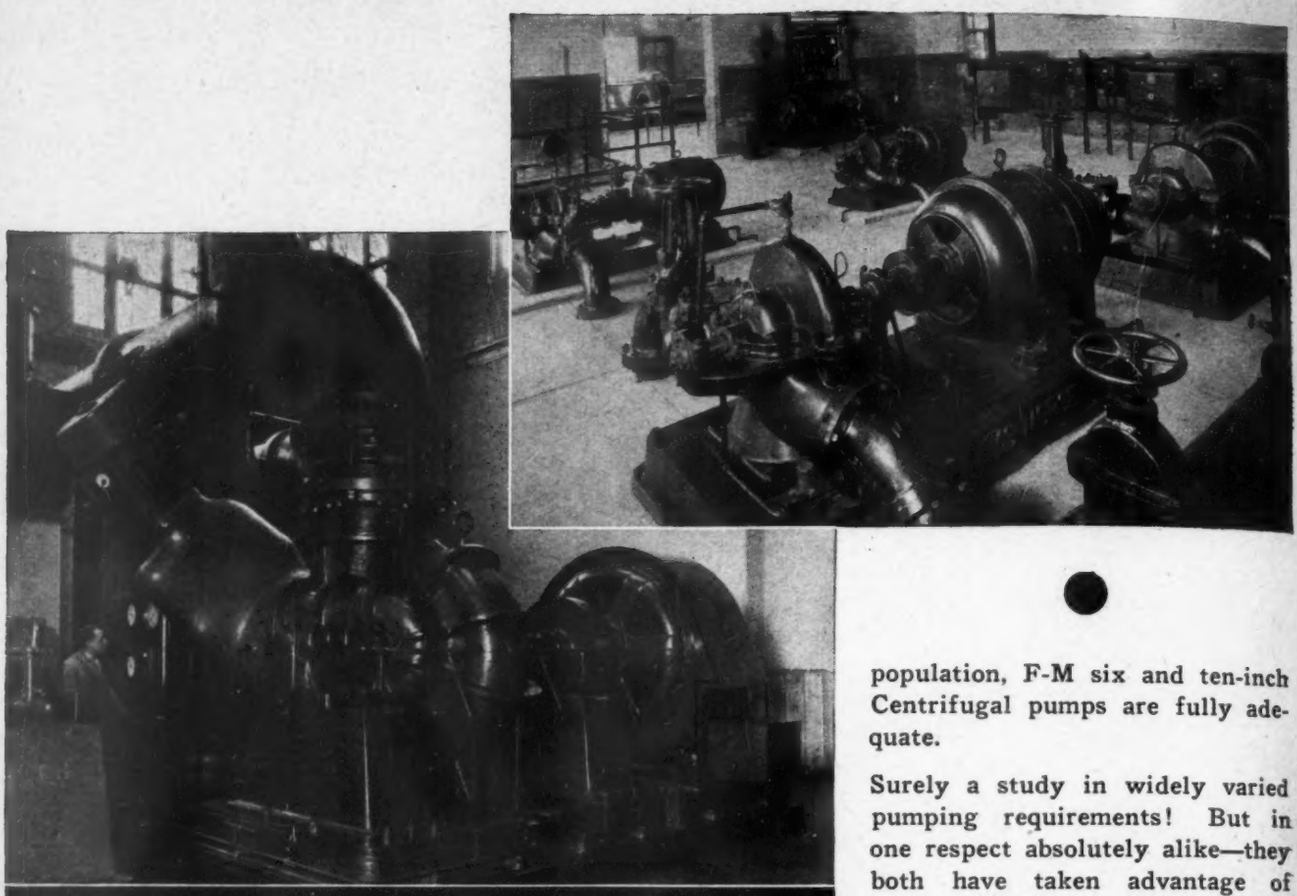

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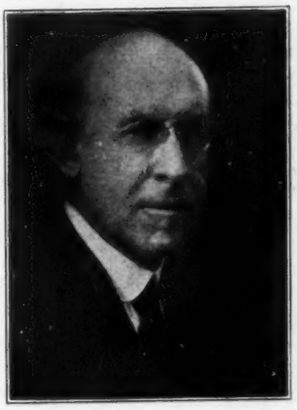
DEVELOPMENTS IN SEWERAGE AND SEWAGE TREATMENT DURING 1933

By HARRISON P. EDDY*



Harrison P. Eddy

IN spite of the improvement in general business conditions which occurred during the latter half of the year, 1933 witnessed little actual construction in the field of sewerage and sewage treatment. A few municipalities during the year undertook sewer-construction projects financed by local funds, largely as measures for the relief of unemployment. As the year drew to a close, construction was commenced on many small sewerage projects in practically every section of the country, with funds furnished by the federal government through the Civil Works Administration. The main object of this work is to furnish employment during the winter and thus reduce the amount of money to be spent for direct relief of distress.

In June, 1933, the foundation was laid for furnishing funds of the federal government to finance socially and economically desirable construction projects, by the passage of the National Industrial Recovery Act. At the end of the year, practically the entire fund of $3,300,000,000 had been allocated by the Public Works Administration to definite projects, to be undertaken by the federal government, and by states, municipalities and other public bodies. Among the non-federal projects to which federal funds have been allocated are many which involve the construction of sewers or sewage treatment plants, but in only a few cases was actual construction started before the end of the year.

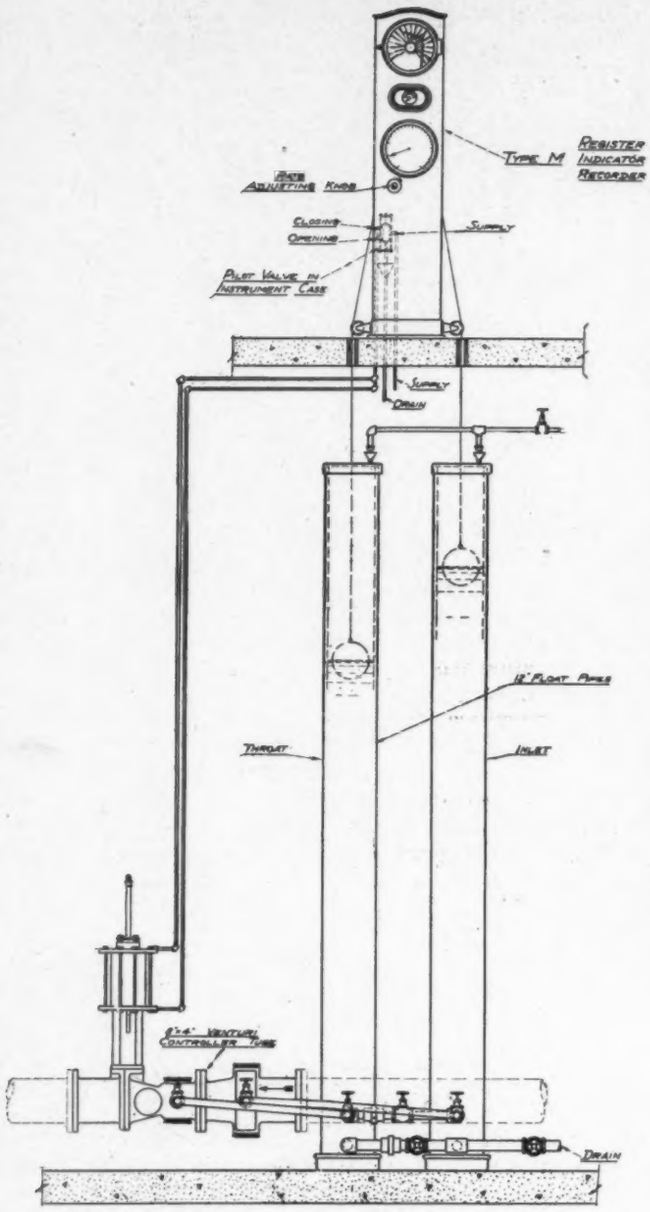
Among the municipalities which carried on relatively large sewer-construction programs during 1933 may be mentioned Louisville, Ky., Beverly, Marblehead, Newton and Springfield, Mass., Springfield, Ohio, and Birmingham, Ala. At Lancaster, Pa., two sewage treatment plants of the activated-sludge type were under construction during 1933 and are scheduled for completion this year. Construction also was carried on during 1933 in connection with additions to an existing activated-sludge plant, serving the North Toronto section of Toronto, Ont. At Birmingham, Ala., and Newark, N. Y., new plants were completed and placed in operation.

In January, 1933, it was reported that the city of Herington, Kan., would begin, within sixty days, the construction of an activated-sludge plant to replace an existing septic tank. The State Board of Health has ordered that the new plant be constructed and in operation by March 1, 1934. [The plant has just been completed—See picture on front cover.—Editor.] The city has contracted to sell the entire flow of effluent from the new plant to the Rock Island Railroad, which will utilize it for boiler and shop purposes.

Measuring and Controlling Rate of Flow.—Although there was a dearth of new construction during 1933, several new developments in sewerage and sewage treatment occurred in the past year. Among them may be mentioned two in the field of measuring and controlling flow.

At a meeting of the Sanitary Section of the Boston Society of Civil Engineers on December 6, 1933, K. R.

*Consulting Engineer, Boston, Mass., and President American Society Civil Engineers.



Rate Controller: Installed at the North Toronto (Ont.) Plant to Maintain Exact and Predetermined Rates (Ratio) of Activated Sludge Return to Variable Flows of Crude Sewage

Kennison described the measurement of sewage flow by means of a new type of open nozzle. This nozzle was developed by the engineering staff of the Metropolitan District Water Supply Commission of Massachusetts, to measure the sewage flow from the Rutland-Holden district prior to discharge into the Worcester sewerage system. It makes possible the accurate measurement of low flows, and a given nozzle is said to measure a much wider range of flows than is practicable with the standard Venturi tube.

An interesting application of the Venturi meter has been made at the North Toronto sewage treatment plant. There Venturi rate-controllers are being installed, by means of which the flow of "return sludge" discharged into the settled sewage can be regulated in a positive manner. The rate-controllers are located on the sludge lines from the final sedimentation tanks and are set by hand to provide the desired rate of flow.

Utilization of Gas from Sludge Digestion.—Until recent years little progress was made in America toward utilizing the gases given off during digestion of sewage solids, although their value has been recognized for many years. When the advantage of heating sludge-digestion tanks to reduce the digestion period was demonstrated, the possible economy of collecting and utilizing the gases of decomposition for heating the sludge soon was appreciated. At some plants notably that at Springfield, Ill., the gases are used as fuel in gas engines, and the collection and burning of gas in waste-gas burners merely to destroy its odor is considered worth while in some cases. Other methods of utilizing sludge gas include heating and lighting of buildings, incineration of screenings, and sale of the gas to gas companies.

At Greenwich, Conn., an ingenious use of sludge gas is that of operating an Electrolux refrigerator in the laboratory of the Old Greenwich sewage treatment plant. G. E. Griffin reports that, with a few minor changes to

84 *Inch Low Level Interceptor Sewer, Springfield, O. Construction Completed to Treatment Plant Now Being Built*

the standard gas burner, the refrigerator has operated perfectly, maintaining a temperature of 40 to 45 degrees F. from June to December, 1933. The quantity of gas used for this purpose is thought to be about 5 cu. ft. an hour.

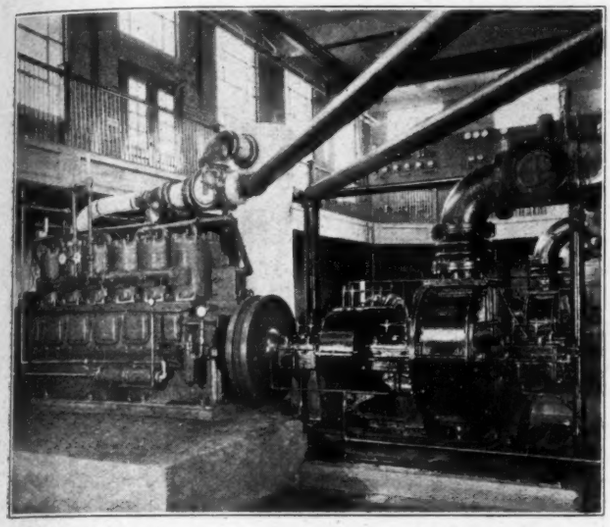
Sludge Conditioning and Dewatering

Although sludge is dried most commonly on sand beds, other methods of dewatering sometimes are used, such as filtering with or without additional pressure or vacuum, and dewatering in centrifuges. Because of the expense of storage tanks or glass-covered beds for disposal of heated sludge, studies have been made during the past few years at Chicago, Baltimore, Cleveland, Columbus, and other places, to determine whether partially or wholly digested sludge could be dewatered mechanically by vacuum filters and mechanically dried or destroyed in incinerators, thus eliminating both storage tanks and sand beds. A large test plant, with a capacity of 20 to 30 tons of sludge daily, was built at Chicago in 1932 and operated for some months, to carry on studies of sludge incineration. At the end of 1933 the incinerator unit in the plant was being replaced with one of a different type.

The principal developments related to sludge dewatering which have been reported during the past year were in methods of conditioning sludge for filtration and in dewatering sludge by spray drying.

Conditioning Sludge for Filtration.—Investigations have been carried on at Chicago, among other places, rel-

ative to the prefiltration treatment of sludge for the purpose of facilitating filtration. The outstanding value of ferric chloride as a conditioner for sludge was reported by F. W. Mohlman and J. R. Palmer in 1928. Since then ferric chloride has been used in practically all sewage works where sludge has been filtered on vacuum filters. In the past few years efforts have been made to find some augmenting or cheapening agent to use with ferric chloride. From laboratory experiments recently made at Chicago, F. W. Mohlman and G. P. Edwards have drawn the following conclusions, which were contained in a paper presented before the American Chemical Society at Chicago in September, 1933: "Substantial reduction was obtained in the amount of ferric chloride



New Gas Engine Installation at Springfield, Ill. Sewage Treatment Works. Heat Is Recovered for Warming Sludge Digestion Tanks After the Gas Has Produced All Power Required to Operate the Air Blowers

required by fresh sludge, by addition of a small amount, 1 per cent or less, of sodium dichromate. . . . A large saving in ferric chloride on digested sludge was indicated by the use of lime, following ferric chloride treatment, in amounts sufficient to raise the pH to 9.0 or more. . . . Paper pulp seemed to have some value as a filter aid if used in large amounts, equal to 50 per cent or more of the weight of dry sludge solids. Moderate heating, from 72 to 90 degrees F., before addition of ferric chloride improved filtration of fresh solids quite noticeably."

Experiments were conducted by A. L. Genter at Baltimore during 1933 on the elutriation of sludge preparatory to mechanical dewatering. The elutriation process is based on the fact that soluble amino and ammonia compounds in sewage sludge are detrimental to the economical coagulation of the colloids by the chemicals used for conditioning the sludge for dewatering. The object of the process is to reduce the proportion of these "ammoniacal compounds" in the sludge before treating it with coagulants preparatory to dewatering. Elutriation consists in mixing the sludge with sewage, effluent, or water, containing a smaller proportion of the amino and ammonia compounds than is present in the sludge, allowing the sludge to settle, and decanting the elutriating water, thus reducing the concentration of the objectionable compounds. The elutriate is returned to the incoming sewage. The Baltimore tests have indicated that the elutriation of sludge prior to conditioning and vacuum filtration effects a material reduction in the quantity of ferric chloride required for conditioning and produces a substantial increase in the yield of the sludge cake.

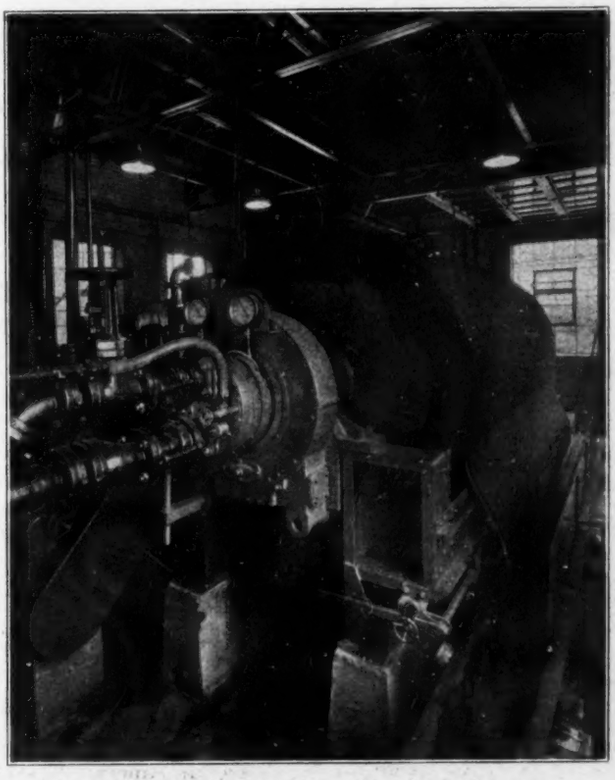
Spray Drying.—The Industrial Associates, Inc., have developed a process for the drying and eventual incineration of wet sludge. The sludge to be dried is stored in a tank, from which it is fed into a centrifugal spray machine and atomized in a horizontal plane near the top of the spray chamber. The dried product falls to the floor of the chamber and is collected by a revolving rake, which delivers into a central chute, discharging into a car or conveyor. The exit gases, laden with moisture and a certain amount of the dust of the dried product, are carried out of the drying chamber through a duct into a cyclone dust collector. So far as is known, no tests of this process on a large scale have been reported, but an installation at Plainfield, N. J., for the spray-drying of sludge is rapidly nearing completion.

Chlorination of Sewage

Chlorine has been applied to sewage or effluents for the purposes of disinfection, retardation of decomposition, reduction of biochemical oxygen demand, control of odors or control of *Psychoda*, cleaning of the distribution system and destruction of surface films on trickling filters. The fact that much of the chlorine applied to sewage is used up by unstable sewage matters is reflected in a reduction in the B.O.D. of the sewage. This effect of chlorination has been studied recently by several investigators, and the available data have been reviewed by the Committee on Sewage Disposal, American Public Health Association. This committee came to the following conclusions in a report submitted to the association on October 11, 1933:

"1. Chlorination, to give residuals of 0.2 to 0.5 p.p.m. after 10 minutes, produces a reduction in oxygen demand of 15 to 35 per cent; the reduction expressed in p.p.m. being roughly proportional to the quantity of chlorine absorbed.

"2. The evidence indicates a reduction of at least 2 p.p.m. of oxygen demand for each p.p.m. of chlorine absorbed, the reduction expressed in p.p.m. being fairly



Vacuum Sludge Filter, Cleveland, O.

constant irrespective of the number of days in the incubation period.

"3. The disturbance of the normal flora and fauna in sewage effluents by the addition of chlorine leads to difficulties in the use of the B.O.D. test which will require further research before the proper interpretation can be made of some of the reported results.

"4. Chlorination sufficient to produce free chlorine in a stream receiving the chlorinated sewage or effluent will retard the normal decomposition processes, thereby tending to prevent anaerobic conditions during the normally critical period of rapid oxygen depletion. Such retardation of decomposition permits opportunity for reaeration and additional dilution from tributary streams to maintain aerobic conditions.

"5. In the case of a stream containing extensive sludge deposits, the effect of excess chlorine carried in a sewage effluent may be negligible in so far as the maintenance of aerobic conditions is concerned."

Chemical Precipitation

A revival of interest in the chemical precipitation of sewage has been in evidence recently. This process, which is one of the oldest methods of sewage treatment, consists of the addition of chemicals to sewage for the purpose of increasing the sedimentation of suspended matter and inducing that of colloidal matter by forming "floc" in the liquid. Sludge is produced in great quantity, often reaching 5,000 gallons of sludge with 7.5 per cent solids for each million gallons of sewage treated. Furthermore, the effluent ordinarily has been putrescible and not comparable with the effluents produced by oxidation processes. These draw backs, together with the expense of the chemicals, have curtailed the use of chemical precipitation and have led to its abandonment in most of the American municipal plants formerly employing the process, notably those at Worcester, Mass., and Providence, R. I. A number of works in Great Britain, however, still employ chemical precipitation. During the past two years, several processes of sewage treatment employing chemical precipitation have been under investigation and have been given some prominence in the technical press.

Laughlin Process.—In 1932 a sewage treatment plant using a chemical-precipitation process developed by W. C. Laughlin was put into operation at Dearborn, Mich. Here the substances added to the screen sewage have been varied from time to time, but in general are pulped waste paper, lime and ferric chlorides. The effluent from the two precipitation tanks is subject to rapid upward filtration through a thin layer of magnetite sand, which is cleaned periodically by a traveling magnetic device. The final effluent is chlorinated and the sludge is dewatered by vacuum filtration. Sludge from plain sedimentation tanks at another treatment plant is discharged into the sewage entering one of the chemical precipitation tanks.

E. C. Miller reports that from October, 1932, to February, 1933, the Dearborn plant treated an average of 2.85 m.g.d. of sewage and 0.25 m.g.d. of sludge. During this period the plant effected reductions of 95 per cent in suspended solids and 88 per cent in B.O.D., based on the composite analysis of incoming sewage and sludge. In Miller's opinion, this plant provides a degree of treatment that is far in excess of that provided by plain sedimentation. He believes that it is sufficiently high to approach that of the activated-sludge process or trickling filters, although it is still somewhat below them.

Guggenheim Process.—Another chemical precipitation process, which is still in the experimental stage, has been developed recently at the Guggenheim Laboratories. This process consists essentially of four steps:

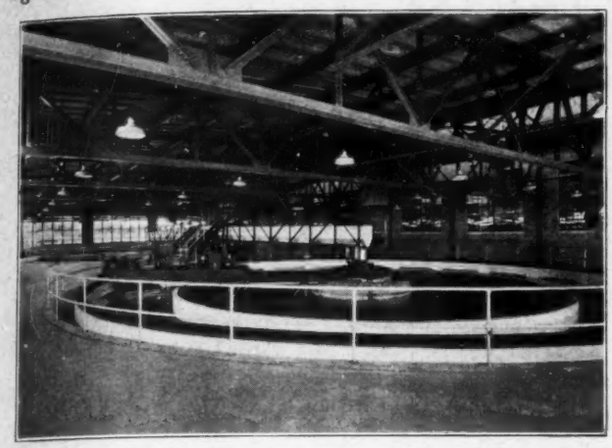
1. Removal of suspended solids by coagulation with iron compounds and lime, and settling the coagulated solids in the form of a sludge.
2. Disposal of the sludge by filtration and complete incineration. Regeneration of the iron as ferric sulphate from the incinerated ash.
3. Removal from the chemical effluent of the basic nitrogen compounds, together with attendant groups containing such elements as carbon, hydrogen and sulphur, by an exchange reaction using a specially prepared zeolite.
4. Regeneration of the zeolite and thereby concentration of the basic nitrogen compounds in the salt solution, and subsequent recovery of ammonia from this solution.

The operating results obtained during six months' operation of a 28,000-g.d. Guggenheim plant at the North Side sewage treatment works of the Sanitary District of Chicago have been reported by G. H. Gleason and A. C. Loonam in a pamphlet dated September 11, 1933.* Iron and lime were added at the rates of 29.6 and 50.0

Structure for the Spray Drying of Digested Sludge; Nearing Completion at the Plainfield, N. J., Sewage Treatment Works

*Elsewhere in this issue appears a "digest" of a more complete and recent report covering the performance of the Guggenheim process at Chicago. See "Meeting of the N. Y. State Sewage Works Assn."—*Editor.*

p.p.m. respectively. The plant effluent showed an average reduction of 90.8 per cent in the 5-day B.O.D. and an average removal of suspended solids amounting to 97.7 per cent. The moisture in the sludge from the clarifier was reduced by a thickener and a vacuum filter from 95.2 to 76.4 per cent prior to disposal of the sludge in a rotary dryer and incinerator. In the operation of this pilot plant, one man takes care of the complete sewage-treatment section. The ammonia-recovery, incinerator and iron-recovery units are operated only on the day shift, each having its individual operator.



One of the Precipitation Tanks and Up-Flow Laughlin Filter With Continuous Cleaning Mechanism, at Sewage Treatment Plant, Dearborn, Mich.

Putnam Process.—Experiments have been carried on lately by A. R. Putnam at Valparaiso, Ind., resulting in the development of a process, the purpose of which is to obtain any desired degree of sewage treatment without the production of odors. In this process, the sewage first receives activated carbon, which removes gases. It then enters a receiving well, where about 5 per cent of the sludge previously removed is returned to the sewage. Milk of lime then is introduced. Ferric chloride is added as a coagulant and the sewage is pumped into a mixing trough and passes into vertical-flow sedimentation tanks. The weight of the carbon aids in precipitating the suspended matter. The effluent is aerated, treated with a sterilizing agent and discharged into a tank, the bottom of which contains a half-inch of carbon supported by a 16-inch layer of sand, if filtering is thought necessary.

The solids settling in the sedimentation tank are drawn off to a sludge tank, the supernatant from which is returned to the receiving well. The sludge from this tank is dewatered by a vacuum filter and passed to a retort, in which all remaining moisture and gases are driven off and the ferric hydroxide is converted into ferric oxide. The charred sludge then is reduced to at least 200 fineness by use of a small hammer mill and passed through a screen, the necessary proportion being applied to the raw sewage, as previously mentioned.

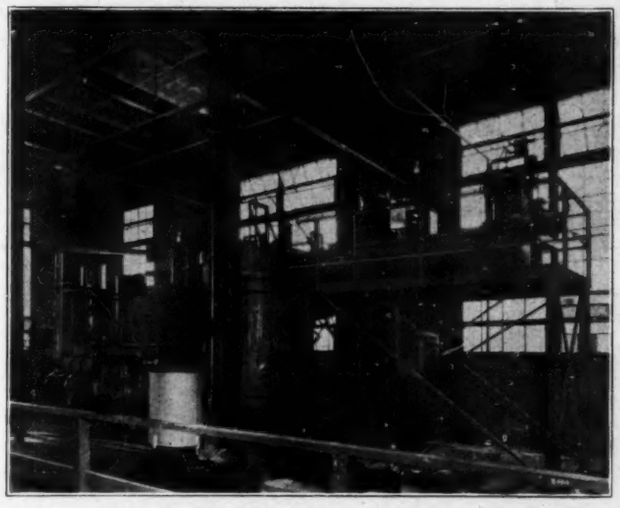
The vapor driven off by the retort is condensed and some gases are absorbed by the water, those not absorbed being carried to the furnace of the retort and burned as auxiliary fuel.

Ferric Chloride Treatment.—From August, 1932, to January, 1933, a small sewage treatment plant was operated by the Great Western Electro-Chemical Co. at Palo Alto, Cal., with the object of determining the effect of the use of ferric chloride in coagulation and the practicability of the Stevenson process of regenerating a spent coagulant through the use of chlorine. In regard to the latter point, it was found that, as regeneration of the coagulant continued, a point finally was reached when the floc would not settle out. Furthermore, the chlorine demand of the spent coagulant increased with each successive regeneration. The regeneration feature has since been abandoned in favor of return of sludge and fresh additions of ferric chloride.

Regarding the use of ferric chloride, however, H. O. Banks has come to the conclusion that a suspended-solids removal of 85-90 per cent and a B.O.D. reduction of 80-85 per cent can be attained, and that the cost of the process would be much less than for any other treatment process in use today which gives comparable results.*

At Grand Rapids, Mich., E. F. Eldridge and N. G. Damoose have studied the feasibility of adding ferric chloride to sewage during short periods of the year in the existing settling tanks, for the purpose of improving oxygen conditions in the receiving stream by removal from the sewage of greater proportions of the solids and oxygen-demanding materials than the treatment plant normally removes. They report that the application of ferric chloride in amounts up to 10 p.p.m. showed an increase in the removal of suspended solids and a reduction in the B.O.D. and chlorine demand. During the eight days of ferric chloride treatment the increase in dry solids removed as sludge was 17.8 per cent. The investigators conclude that the use of ferric chloride during short periods of the year may be justified, if conditions in the stream approach the critical stage.

Paper Pulp Filtration.—At Rockville Centre, N. Y., vacuum filters have been installed, to filter the effluent from an activated-sludge plant, as well as the effluent from primary settling tanks preceding activation. The process involves a modification of chemical precipitation, in that paper pulp is added to the sewage before filtration, the paper fibers entangling the suspended solids to form a mat on the filter. The purpose of the installation was originally to reduce the quantity of suspended solids reaching the sand filters, which constituted the final step in the sewage treatment process. Lately, however, the effluent from the vacuum filters has been discharged direct to the small streams.

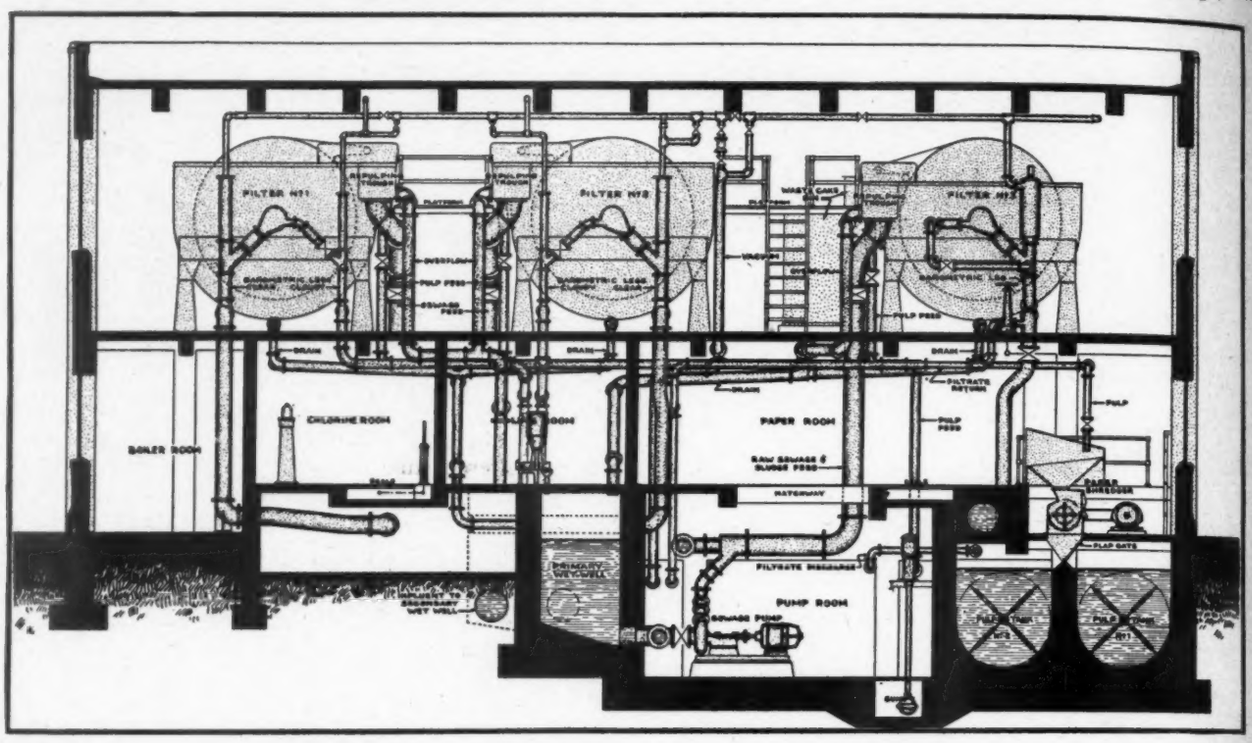


Demonstration Plant, Guggenheim Process, Chicago, Ill.
1—Head Box; 2—Dosing and Mixing Channel; 3—Clarifier; 4—Zeolite Filters; 5—Incinerators; 6—Ammonia Still

In a paper presented before the New York State Sewage Works Association at Rochester, N. Y., on June 9, 1933, W. G. Taylor described the method of paper-pulp

*The plant nearing completion at Birmingham, Ala., will employ a modification of the return sludge process making use of ferrous-sulphate and chloride (chlorinated copperas) as the coagulant. The final effluent will be mechanically filtered.—Editor.

filtration. Since, however, the process has been somewhat changed to meet operating conditions and reduce paper consumption. Pulp made from waste paper is pumped into the filtering equipment and there disseminated through the incoming sewage. Upon application of a low vacuum the mat is formed on the filter. The same pulp after washing may be used throughout many cycles of operation. Waste cake is added to fresh sludge which is dewatered by vacuum filtration and incinerated.



Section Through Filter Building, Sewage Treatment Works, Rockville Center, L. I.

A lime-feed machine has been installed in the filter plant at Rockville Centre, for use in adjusting the pH value of the sewage before filtration, when necessary. The waste water from the continuous pulp washer is discharged to the crude sewage.

Conclusion

Practically all the processes of chemical precipitation which have been mentioned are still in the developmental stage. Until sufficient time has elapsed for the accumulation of adequate data on the efficiency and operating cost of these new chemical-precipitation methods, based on the operation of full-scale plants, it will be hazardous to predict the position which modern chemical precipitation processes will be accorded in the field of sewage treatment.

Although the year 1933 found construction activities in the field of sewerage and sewage treatment at a low ebb, 1934 gives promise of a revival of such construction under the federal public-works program. That a large sum of money is to be spent on sewerage construction in the near future is indicated by figures released on January 15, 1934, by the Public Works Administration. At that time, $818,472,598 had been allotted from the public works fund to specific local government units or regulated bodies outside regular federal units. Among some 1,800 non-federal projects for which allotments had been made, 337 "sewer projects" were included. These projects involve construction of sewage treatment plants as well as sewerage systems. It is highly probable, therefore, that the present year will bring much more construction of sewerage and sewage-treatment facilities than did 1933.

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A 50-Year Index to Journal of the A. W. W. A.

The American Water Works Association announces that there has been prepared, under one cover, a complete index to cover 53 years of the Proceedings, the Journal and Other Publications of the Association from the earliest issue (1881) through 1933.

Such a complete and comprehensive index was badly needed and will make for ready finding of articles published by the Association during its life, classified according to subject matter, and authorship. It is also cross indexed and thereby makes readily available reference to the voluminous but scattered information contained in the Association publications.

This index has been compiled under the direction of A. V. Ruggles, Assistant Secretary of the Association. It contains 200 pages and is bound in stiff buchram covers. The index has been printed in a limited edition for sale to members at $1.50—a price less than actual cost of production. To non-members the price is $2.50 per copy. Orders are now being taken at the Association office at 29 West 39th St., New York City, for filling on or about February 15th. A sufficient number of copies will be reserved for supplying foreign members.

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Probably a Record Per Capita Demand

The Water Department of Lake Forest (pop. 6,000) has at times a peak demand not believed to be exceeded in any city. This suburban village of Chicago, with its many notable estates, covers 13 square miles. On one summer's day the water plant pumped 6.2 million gallons—an average 24-hour demand of over 1,000 gals. per capita served. The average consumption per capita per day for the maximum year has been 260 gals.—i. e. 562 m. g. pumped during the year to serve 6,000 people.

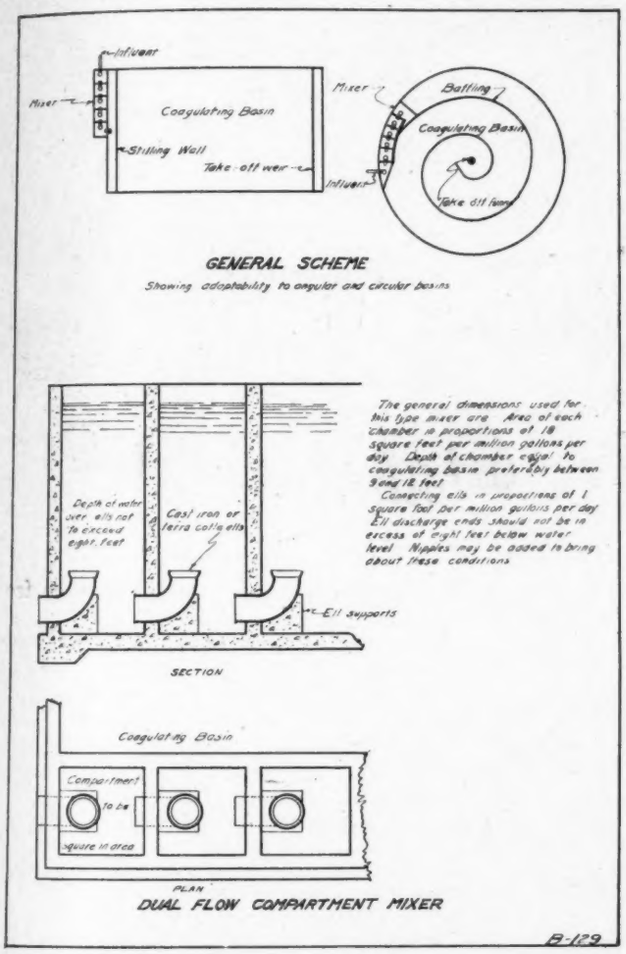
DUAL FLOW COMPARTMENT TYPE MIXER

By HARRY G. MENKE

Assistant Sanitary Engineer,
Alabama State Department of Public Health, Montgomery, Ala.

EXPERIMENTATION and practice have proven conclusively the advantages of obtaining a thorough mixing of coagulating chemicals with the water to be prepared for filtration through rapid sand filters. Advantages accruing from a properly mixed water include: better clarification due to increased floc size and consequently more rapid settling; smaller chemical dosages; and less coagulating basin capacity.

Mixing chambers have passed through different stages of advocacy, from the highly baffled, high velocity, large


Influent
Mixer
Coagulating Basin
Stilling Wall
Take-off weir
Mixer
Baffling
Coagulating Basin
Influent
Take off flume
GENERAL SCHEME
Showing adaptability to angular and circular basins
The general dimensions used for this type mixer are. Area of each chamber in proportions of 18 square feet per million gallons per day. Depth of chamber equal to coagulating basin prefer bay between 9 and 18 feet
Connecting ells in proportions of 1 square foot per million gallons per day. Ell discharge ends should not be in excess of eight feet below water level. Nipples may be added to bring about these conditions
Depth of water over ells not to exceed eight feet
Cast iron or terra cotta ells
Ell supports
SECTION
Coagulating Basin
Compartment to be square in area
PLAN
DUAL FLOW COMPARTMENT MIXER
B-129

General Scheme, Section and Plan of Dual Flow Compartment Mixer

loss of head types to the mechanical types with lower velocities and practically negligible loss of head. Each has advantages and disadvantages all of which have been the subject of discussion and each is fairly well catalogued in the mind of the designer of water purification works.

It is not the intention of the author to write a controversial article, but to bring before his readers a type of mixer which has not had widespread application in the country outside of Alabama.

The type has been suggested to designers for construction in Alabama by the State Department of Health and has been built at a dozen plants ranging in size from 100,000 g.p.d. to 3,000,000 g.p.d. normal capacity, with uniformly good results.

We call this type the dual flow compartment type mixer and it consists of a series of compartments, usually five, in which the water flows upward and downward in each compartment. The upward flow is induced by the jet action of a submerged horizontal orifice and the downward flow is the result of gravitation.

In the theory of proper mixing the writer has always leaned towards the aim of getting an independent movement of the particles of the floc in the water so that coalescence may be induced after coagulation has been attained.

It is the coalescence which is the big factor in sedimentation. Any mixer which will encourage the independent movement of the floc tends to bring the particles into impact with each other as compared to their keeping their relative positions in the carrying medium. Because the specific gravity of the floc particles is not much different than that of the water this independent movement of the floc is difficult to attain. In the highly baffled over and under or around the end baffled chambers the path of the water is rather definite with but little turbulence. At no time is the water turned back to itself to allow the impact. This reversed direction is contained to an extent in the herringbone mixing troughs and also in mechanical mixers. Counter currents in the water body are set up with the resultant desired impact.

The dual flow compartment mixer as advocated by this department obtains the counter currents and impact with slight loss of head and with no outside cost or mechanical maintenance.

The mixer is explained by the accompanying drawing. Two installations are indicated to show the installation and relation of the mixer in an angular and a circular basin. Individual design will, of course, alter the construction to suit existing conditions.

The pictures show installations, at plants in Alabama,

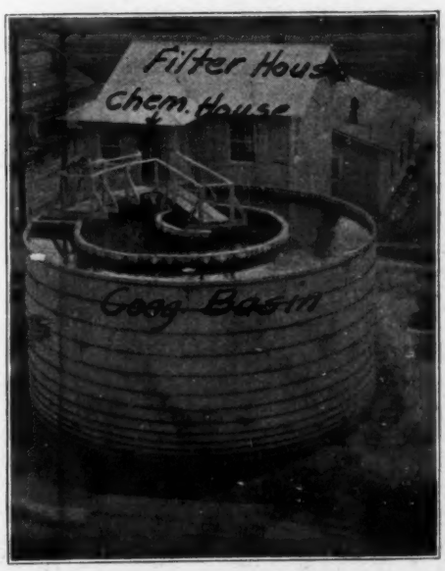


Fig. 1—General View of a Circular Basin

of the mixing chamber in the rectangular and circular basins.

Figure 1 shows a general view of a circular basin. The discharge end of the mixing chamber shows under the end of the left angle of the inspection walk. The outlet from the coagulating basin to filters is under the end of the right angle of the inspection walk. Inlet into the mix chamber is at the junction of the two inspection walks.

Figure 2 shows the layout of a mixer in a circular basin. Raw water from the source of supply enters at the bottom of the first compartment and coagulating chemicals are discharged into the top of this first compartment.

Figure 3 shows a rectangular parallel, coagulating basin with the transverse baffling. Mixer, not shown, is at the left end.

Figure 4 shows the mixer of the coagulating basin pictured in Fig. 3. Note the shear gate handles at the com-

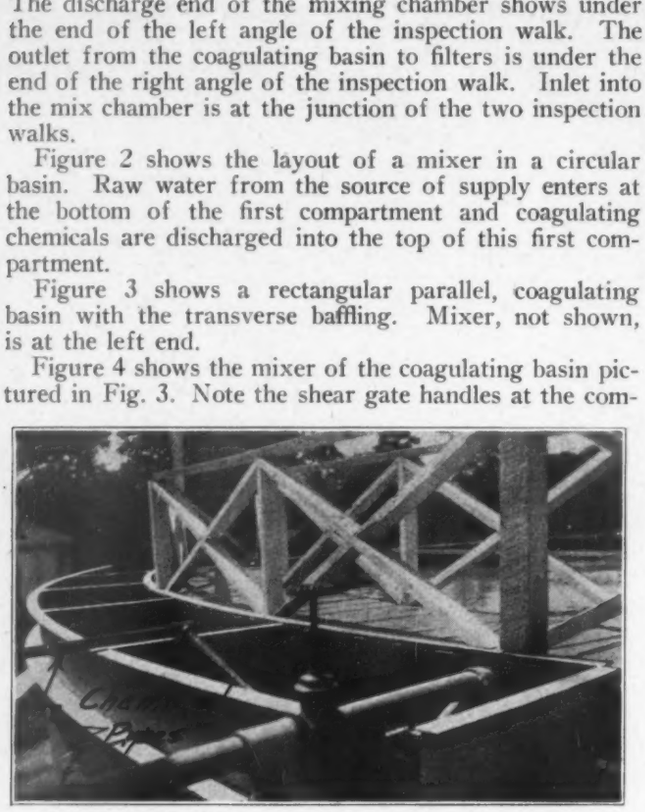


Fig. 2.—Layout of a Mixer in a Circular Basin

mon inlet chamber and the stilling well at the lower left corner of the picture. Chemical lines shown leading into inlet chamber.

The elements of design are as follows:

The compartments are usually five in number.

Each compartment should have an area or plan of eighteen square feet per million gallons of water per twenty-four hours of filter capacity.

The depth of the compartment is usually from nine to twelve feet or the depth of the average coagulating basin.

The connecting ells should have areas of one square foot per million gallons of water per twenty-four hours of filter capacity. For a million gallon plant the commercial size of ells would be fourteen inches for cast iron specials.

The discharge ends of the ells should not be greater than eight feet below the water level in the compartment. If the basin is deep a short nipple should be placed in the discharge end of the ell to bring the outlet up to the eight foot level. Six or eight feet has been found to be good limits.

The loss of head will be about one foot through a

Fig. 3.

Fig. 4.—Mixer of Coagulating Basin Shown in Fig. 3

series of five compartments which should be as nearly square as is possible and length to width ratios should not exceed 1.33 to 1.

The stilling, or applicator, wall should provide for even dispersion throughout the cross section of water travel in the sedimentation basin. Design, allowing for one inch loss of head through the wall, with openings tapered from small inlet side to enlarged outlet side to prevent jet action, has given good results. Some plants have introduced flexibility in their design by having the last two compartments opening into the stilling chamber with shear gates for control.

In the building and operation of this type mixer in Alabama for the past ten years, we have found:

That they are easy and economical to construct.

They are easy to cleanse, due to the relatively large openings as compared to highly baffled chambers.

That they are very effective on small as well as large plants and solve the problem of getting a good mixer in a small plant and still have an economical, easily operated, mixer.

The rolling, boiling motion imparted to the water seems to coalesce the floc particles much the same as a snowball grows when rolled down hill.

That a real "sweeping through" action is attained and the floc formed settles quickly.

That the loss of head is kept remarkably low and that maintenance and operation costs are negligible.

This design is not original with the Engineering Division of the State Department of Health, but has been probably put into greater use in Alabama than elsewhere and has always given satisfactory results.

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Malcolm Pirnie Returns to His Engineering Practice

The codification of the construction industry having been completed, Malcolm Pirnie tendered his resignation as Deputy Administrator of the NRA to Col. Hugh S. Johnson, Administrator, on January 10th.

Mr. Pirnie has resumed his private engineering practice at 25 West 43rd St., New York City, where he can give closer attention to his official position as "President of the American Water Works Association, and Chairman of the National Recovery Committee for Water Works Construction."

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RE-USE OF WATER—The Southern Railway recently opened a new locomotive depot at Hither Green, S. E., England, the site of which had been raised to the adjoining main-line level. A special feature has been made of the water supply. The water utilized for engine cleaning will, after use, be filtered and cleaned by means of a specially designed plant and recirculated.

RESULTS FROM THE USE OF ACTIVATED ALUM AT BATAVIA, N. Y.

By HERBERT M. COOK

Superintendent of Pumping and Filtration, Batavia, N. Y.

The Author

THE city of Batavia, New York, secures its water supply from Tonawanda Creek. The drainage area is approximately 160 square miles, much of which is agricultural, causing an unusually heavy algae load on the filter plant during certain times of the year. The present plant was placed in operation in 1918 but has had improvements added since and we are just now completing electrification and revamping of the pumping station. The plant is equipped with a complete laboratory and the writer personally conducts all of the necessary tests. The County Health Department Laboratory also examines samples of filter effluent and chlorinated water each day.

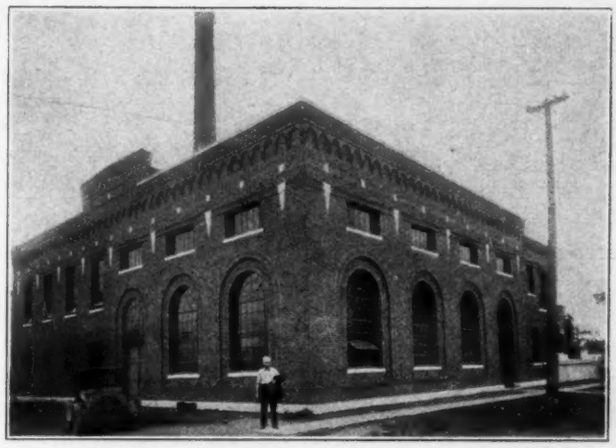
Our past experience has shown us that during the summer months we always have a period of very bad water due to the nature of the water shed and decomposing vegetation and algae. Tastes and odors, which cause complaints from consumers are often present. The writer was familiar with the success of activated carbon for controlling tastes and odors but had never used it. The announcement of the new activated carbon compounded alum, which has been dubbed "Blackalum" because of its black color, interested the writer because of claims of improvement in coagulation and production of a more palatable water. It was the claim of the manufacturers that this activated-alum would give the benefit of activated carbon for sweetening sludge and thus produce a floc that would not decompose in the settling basin or on the filter sand.

Results from a Trial Shipment of Blackalum

On August 28th we started to use a small experimental shipment of this activated alum purchased from the Pennsylvania Salt Manufacturing Co. It just happened that at this time there was a rank taste and odor in the water due to decayed vegetation and algae and although the new alum was not supposed to contain sufficient carbon to cope with severe tastes we felt that conditions would give it a good test. One of the immediate results which was readily apparent was the quicker forming and larger floc produced, but the taste of the water was not improved. We liked the improvement in the floc and kept on using the new alum. Then, after about two weeks' time a decided improvement in taste of the water was noticed although conditions of the raw water had not changed for the better.

The manufacturers state that Blackalum contains only 2 per cent of activated carbon and it is hard to understand how such a little carbon can make white alum so black. The 900 billion particles of carbon dust said to be in each pound of black alum may explain this and other phenomena observed as the result of its use at Batavia.

We used the dry feed machine to feed this alum to the raw water suction well (where prechlorination has also been applied for some time)—just as we had been feeding ordinary alum. The average alum dosage being used at the time was 1.7 grains per gallon and the chlorine dosage was 4 to 5 lb. per million gallons. Post chlorination of the filtered water at from 1 to 2 pounds per million gallons is also our regular practice. It was soon apparent that the old rate of alum feed was more than we needed with the new alum and we gradually dropped the feed back to where the floc was weakening and then stepped it up a little to get a floc that was entirely satisfactory.



Filter Plant and Pump Station, Batavia, N. Y.

Our first lot of "Blackalum" was 5 tons which lasted for 45 days. During this period we treated 50,210,000 gallons of water which, if figured out, gives an average dosage of only 1.4 g.p.g. For the 45 days preceding the change, with pH and turbidity and all other conditions as nearly alike as could be, we treated 67,620,000 gallons and used 16,640 lbs. of regular alum which, figured out, amounts to an average 1.7 g.p.g. We figure we used about .30 g.p.g. less of "Blackalum" than ordinary alum and got far better results, including the taste improvement which we noticed after the first two weeks. We presume that it must have taken that long for the small carbon dosage added (0.028 g.p.g) to sweeten up the basins and filters. This carbon dosage in reality should be deducted from the calculated 1.4 g.p.g. because only 98 per cent of the activated alum is alum and therefore the true alum dosage was only 1.37 g.p.g., making a net saving in alum of 0.33 g.p.g. This saving of about 20 per cent in coagulant required more than makes up for the slightly higher cost of the "Blackalum."

When the trial lot of the new alum was gone we went back to the old alum and in about five days we began to hear from consumers about the taste and odor of the water. I can say that there was a just cause for these complaints and we lost no time ordering a car of "Blackalum" from the Pennsylvania Salt Manufacturing Co. to be shipped at once. We started again to use the acti-

vated alum immediately and in about five days the complaints stopped and we haven't had one since.

Effect on Sludge in Basins and Floc in Filters

Since going over to activated alum we have washed the settling basin only once. It had been in service about six months and we intentionally let it run longer than usual to test out the claims that the carbon in the floc would stabilize the sludge. When cleaning the basins it was evident that the activated alum had stabilized, or at least deodorized, the sludge because there was practically no odor to it. Ordinarily we would have washed the basin in August instead of October as it is our practice to wash in April, August and November.

Conclusions

Based on our experiences with the use of activated alum it seems to be a more flexible coagulant for our water and gives a quicker forming floc which is larger and more easily controlled. The floc or sludge does not seem to decompose in the settling basins or in the filter sand as it did with alum, even when using prechlorination. In addition to the improvement in coagulation and taste and odor control obtained, the use of activated alum at our plant has resulted in a 20 per cent reduction in the alum consumption.

We have also noticed that we are using less wash water than we did and the filter beds are in better condition than they were before we started using "Black-alum."

The writer has seen nothing in the technical magazines about this new alum and thinking that his experiences might be of some benefit to others he is offering them, and at the same time would be glad to hear from other water works men who have tried it.

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Reconditioning Filters*

BY MAX U. PRIESTER

Supt. of Filtration, Suburban Water Co., Verona, Pa.

THE problem of keeping filters in good condition is one with which most every plant has to deal. I will give you briefly the procedure used in reconditioning the filters at our plant, and some of the results obtained.

In general, all the filters at our plant were in such condition that ordinary raking had little effect on them. The sand was stained and coated with manganese and iron. Mud-balls, and hard spots existed all through the filter. The sand would crack and pull away from the walls and had a tendency to build up at the ends of the filter and it was impossible to keep the surface level. Organic material was deposited all through the sand which even after routine washing gave off offensive odors.

In the reconditioning process used at our plant the filter was first washed in the ordinary way. The water was then drawn down to within approximately 36 inches of the sand, and a solution of chlorinated lime was added and thoroughly mixed with the water. From 15 to 20 pounds of this material was used, representing a dosage of approximately 50 parts per million. The filter was allowed to filter to waste long enough to draw the chlorinated water down into the sand and graved. Then the filter was allowed to soak about 48 hours with this solution thoroughly saturating the sand and gravel. At the end of this period the filter was given a very short wash, then drained empty and the sand dug into furrows to allow as much air as possible to be in contact with the sand. A filter was usually allowed to stand this way for a day or so to obtain as much drying as practicable.

After this the sand was leveled and another washing given it. A connection was made to a fire hydrant on the high pressure line by means of a fire hose. This was reduced to a 1 inch hose and to the end of this was attached a 1 inch pipe about 8 ft. long. The filter was washed at a very low rate, just enough to have a flow into the wash troughs, and the pipe wash was begun. The pipe was handled by two men and continually brought up and down in the sand bed. It was pushed down to the gravel and brought up again over the entire bed. Thus the whole bed of sand was completely agitated and the pressure was in every part of the bed and carried down through the gravel with every vertical and horizontal movement of the pipe. A certain amount of care had to be taken to be sure that the gravel was not dislodged by this treatment. Incidentally, I might say that a 2 inch pipe was tried, but due to the pressure and weight it was too cumbersome to handle and greater efficiency was obtained when using the 1 inch pipe.

When the washing was started the visible effect was astounding. Heavy dark clouds of managanese, mud, etc., were washed out. With every downward plunge of the pipe there seemed to be a cloud of material stirred up and carried away by the wash water. A small amount of sand was lifted into the wash troughs, but no appreciable amount. Finally after the filter had been thoroughly flushed all over, the water began to clear up and when the entire bed was cleared the pipe washing was stopped. We were then unable to locate any hard-spots or mud-balls. Upon examination the sand was visibly cleaner, the bulk of the stain had been removed and the sand was left level over the entire surface of the bed.

After the filter had been put back in service the effect of the special wash was more convincing. The filter washed much easier and cleaner. There was no cracking of the sand or pulling away from the side walls, and above all, the bed was absolutely free from odors. A very noticeable effect observed was that of increased length of filter runs.

On one filter chlorine was used. In this procedure the filter was filled to capacity and heavily dosed with chlorine gas. After as much gas as possible had been put into the water, and the water was drawn down into the sand and gravel, the incoming water was heavily dosed as it entered the filter. The remaining steps in the procedure were the same as when chlorinated lime was used. The results were practically the same. This method of reconditioning filters is not difficult, and yet it is very effective. Naturally, it is not a cure-all for all filter troubles, but the life of the filter and its effectiveness when in use is well worth the time and effort required to apply the treatment.

*This paper, read before the Pennsylvania Water Works Operators Association, at State College, Pa., was adjudged by a committee as being the best operating paper presented, winning, thereby, the President's Award of a two years' subscription to WATER WORKS AND SEWERAGE.

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SPRINGFIELD, ILL., WATER AND LIGHT DEPARTMENT TO SPEND $2,223,000—The Water, Light and Power Department of Springfield, Ill., will spend $2,223,000 during the next fiscal year in the development of Lake Springfield projects. The budget for the water department calls for an expenditure during the year of $1,868,000. Operating expenses will total about $290,000, which leaves $1,578,000 available for equipment for the new power plant, building of a purification plant, new water mains and riprap work. A federal loan of $1,386,000 will be used on the work.

MEETING OF THE N. Y. STATE SEWAGE WORKS ASSOCIATION

Rockville Center Sewage Treatment Plant. View of New Vacuum Filter Building Looking Across Primary Clarifier from the Blower House

THE New York State Sewage Works Association held its Winter meeting at the Hotel McAlpin in New York City on Jan. 16th. A registration of 198, with an attendance of 225 or more, represented the largest in the history of the association.

In the evening the joint dinner of the N.Y.S.S.W.A. and the Sanitary Engineering Division of the American Society of Civil Engineers (103 present) was presided over by Professor Charles Gilman Hyde of the University of California.

As the speaker of the evening, Professor Hyde introduced Abel Wolman, P.W.A. Engineer for Maryland and also Regional Advisor to the P.W.A., who reviewed the trends and developments in public utility financing from 1929 to date. He commented on the striking change in the psychology of American taxpayers, who in early 1933 could not have been persuaded to vote bonds for anything, were now approving and vigorously backing applications for Federal funds for public works construction in order to pull the nation out of the depression by its own boot-straps.

To date 765 water and sewage projects had been accepted by the P.W.A. for allocation of funds—the larger number (428) being for water works betterments but the greatest expenditure being for 337 approved sewerage projects. In an uncensored analysis of Federal aid programs; the attitude of municipal authorities; the viewpoint of the governmental agencies—and the responsibilities of each—Mr. Wolman's presentation was brilliant.

Harrison P. Eddy Luncheon Speaker

The association was honored by the presence of Mr. Harrison P. Eddy, President of the American Society of Civil Engineers, who appeared as the luncheon speaker. He presented a brief, informal and interesting review of "Developments in Sewerage and Sewage Treatment During 1933."*

Tuttle Relates P.W.A. Developments

Arthur S. Tuttle, P.W.A. Engineer for New York State, set forth the present status of federal aid to sewerage in New York State. He acknowledged the considerable assistance given by the engineers of the State Department of Health in the work of his office and in stimulating authorities to proceed with water and sewage projects. Applications for loans and grants had been filed to cover 61 water projects and 62 sewage projects. Of the latter 36 had been reported out to Washington, 8 had been withdrawn by applicants, 5 had been transferred to the C.W.A. and 13 were pending. The total sum represented is 58 million dollars and but 4 or 5 projects were in excess of one million dollars.

*A review prepared by Mr. Eddy for WATER WORKS AND SEWERAGE, which appears in this issue, covers among other things essentially what was said in his talk.—Ed.

Kenneth Allen Memorial Award

The annual award of the Kenneth Allen Memorial Plaque was this year made to two members who had presented outstanding papers before the Association during 1933.

L. L. Luther, Engineer in Charge of Sewerage, Freeport, L. I., received the award for his paper—"Chemical Precipitation as an Adjunct to Sewage Treatment"—which was based on studies of the merits of chemical precipitation at the Freeport Sewage Treatment Works on a plant scale.

Morris M. Cohn, Superintendent of Sewage Treatment, Schenectady, N. Y., received the award for his "Report on the Operation of the Schenectady Sewage Treatment Works," which was adjudged, "stimulating to operators faced with reduced budgets and adverse operating conditions."

Business and New Officers

Officers elected for the ensuing year were:
President—E. B. Besselievre, New York, N. Y.
Vice-President—M. M. Cohn, Schenectady, N. Y.
Secy.-Treas.—A. S. Bedell, Albany, N. Y.
Executive Committee (New Members)—M. M. Cohn, H. W. Taylor, L. H. Enslow.

The following important resolution was passed by the Association at the suggestion of the Committee on Licensing of Sewage Works Operators. It will be noted that a "Licensing Act" is not recommended. Instead, the "fixing of qualifications of plant operators" by the Public Health Council is deemed more practical.

> "Now, therefore, be it resolved: that it is the sense of the N.Y.S.S.W.A. in annual meeting assembled that the Public Health Law be amended to more adequately secure these results [efficient supervision and tenure of office of competent operators at sewage works] through enlargement of the functions of the Public Health Council to include the fixing of qualifications of plant operators, or by any other means. . . . Be it further resolved, that the New York State Commissioner of Health be requested to use any means at his command to secure these results."

The Executive Committee selected Jamestown, N. Y., as the place for the Spring meeting to be held June 15th and 16th.

Inspection Trips

On the morning following the meeting a group of 100 or more visited the sewage treatment plant at Rockville Center, L. I., for which purpose buses were provided by the Municipal Sanitation Service Corporation which has recently installed a novel process involving the use of vacuum filters at the Rockville Center activated sludge plant. The use to which these units are put are two fold —two units being operated to filter the plant effluent with the aid of added paper pulp to absorb solids and form the filter mat, and a third is used to dewater mixed fresh solids and excess activated sludge or, when desired, to filter settled or crude sewage.† The sludge cake is burned in the municipal garbage incinerator.

This addition to the Rockville Center plant [capacity of 3 m.g.d.], made at a cost of approximately $125,000, has made it possible to economize on operation of the activated sludge process and to discontinue maintenance

A Group at the Rockville Center Plant. Left to Right: Hess, Agar, Bingley, Bugbee, Wycoff

of sand percolating beds which had been giving difficulties from clogging by suspended activated sludge carried over by bulking. The mechanically filtered effluent is now chlorinated and discharged with a B.O.D. value of 5 p.p.m., direct to a small stream.

Following the luncheon served in the filtration plant by Municipal Sanitation Service Corporation, a large group visited the new Sanitary Engineering Laboratories of New York University as the guests of Professor Thorndike Saville.

Technical Sessions

(A. F. Dappert presiding)

The technical sessions were opened by a paper by Professor EARLE B. PHELPS, who made a **"Preliminary Report on the Investigation of Pollution of the Hudson River."**

Professor Phelps reviewed the work of studying the pollution loading of the Hudson River and harbor-waters contiguous to New York City during the past 22 years. He told of the studies conducted during the past two years by himself and his associates as a joint undertaking with the New York State Department of Health to study the pollution and self purification of the Hudson above New York City. He remarked, that the old formula for effects of pollution loadings on oxygen content of the harbor waters during future years, developed by Phelps and Black 22 years ago, and considered radical at the time, had been found in 1919 to be but 5 per cent off of those predicted in 1912. A modified formula was in the process of development which would take into consideration run off for areas above New York City. Decrease in dissolved oxygen content of New York harbor waters had been up to two years ago exceeding the trend line based on contributing population and the assumed 0.2 lbs. of oxygen required per capita per day. More recently, however, the oxygen depletion had dropped below the trend line.

DR. GEORGE A. SOPER, Consulting Engineer, New York City, and formerly at the head of the New York Metropolitan Sewerage Commission, said that he believed too much attention and discussion had been devoted to the dissolved oxygen content of polluted waters and the oxygen demand values of sewages. He thought that the dissolved oxygen content discussions were academic and had been responsible for too much argument and delay in getting some practical degree of sewage treatment under way. Such matters as removal of solids to prevent sludge banks from forming and prevention of foul odors and floating solids, seemed far more practical for consideration in setting down basic requirements. The standards of the Metropolitan Sewerage Commission had included such basic requirements in its standards for effluents, intentionally neglecting to specify controversial dissolved oxygen values in waters contiguous to sewer outlets. Bacterial standards had been set, however, for effluents reaching bathing and shell-fish areas. Regardless of this, every standard of decency had been exceeded in New York waters and this condition primarily reflected the astounding indifference of the public. Reverting again to standards, he considered the heavy work of suspended solids removal to be the all important accomplishment in cleaning up waters. This step would take care of local problems, which after all must be appreciated as more important than that of effluent diffusion which could be taken care of by future steps of secondary importance.

GEORGE W. FULLER, Consulting Engineer, New York City, spoke on the practical aspects in getting pollution abatement under way. Whereas, technical discussion had gotten nothing done in 25 years, publicity through the press and interest of realtors had gotten the New York's Ward's Island Project under way in a short time. He was of the opinion that as long as *some* dissolved oxygen remained in the water no nuisance or other trouble would result. Certainly 10 per cent would prove ample for the harbor waters and he was in agreement with Dr. Soper's viewpoint, but none the less appreciative of the excellent work of Professor Phelps.

RICHARD H. GOULD, Engineer of Sewage Treatment, Department of Sanitation, New York City, said that studies of the past four years had indicated continuously poorer conditions in the waters contiguous to metropolitan New York. He believed that the problem would be solved best by some evaluation of ratio of oxygen demand values of effluents and the natural oxygen supply available in the waters of given areas. He added, however, that studies under way indicated that sanitarians had been underestimating the importance of the oxygen demand of settleable solids as compared to that exerted by the liquid and non-settling solids in sewages. Whereas, primary treatment (solids removal) has been evaluated through laboratory oxygen demands (B.O.D. tests), and compared to that removed by secondary treatment, their observations pointed to the need of crediting of higher values, as a practical consideration, for solids removal than the measuring sticks (B.O.D. tests) used in laboratories indicated. The excessive demands exhibited by sludge deposits may change the comparative

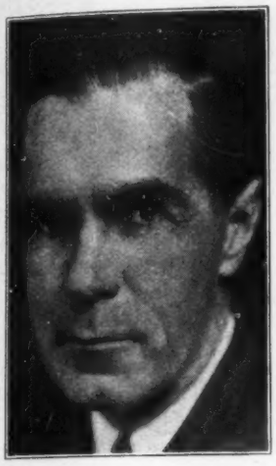
†The process and equipment was described fully in WATER WORKS AND SEWERAGE, August, 1933, by Wm. Gavin Taylor, C.E.—pp. 265-269.

evaluation of primary vs. secondary treatment of sewages when considered on a basis nuisance prevention.

PROFESSOR PHELPS said that he fully appreciated the practical aspects of Dr. Soper's remarks and standards set up; that the oxygen demand and dissolved oxygen values were at best yardsticks to be used in reaching predictions and evaluating accomplishments. The observations of Mr. Gould were in line with expectations for local areas where sludge solids demanded 100 per cent of their oxygen requirement and this in a limited area.

"Digester Overflow Liquor—Its Character and Effect on Plant Operation"—DR. A. J. FISCHER, The Dorr Company, New York City.

Dr. Fischer listed the characteristics and volumes of digester overflow liquors at several representative sewage



E. B. Besselievre, President of the Association

J. S. Kneal, Superintendent of Sewerage, Rockville Center, L. I.

plants grouped according to the nature of sludge being digested. He said the volume and ill effects produced by supernatant liquors were most marked by far at activated sludge plants, because of the great volume of dilute sludge input to digesters and the viscous nature of the digester overflow. When added to the aeration tanks or crude sewage, it caused serious upsets in operating conditions.

The minimum requirement for digesters had been shown to be 3 cu. ft. per capita when receiving activated sludge and crude solids. The pre-thickening of the wasted activated sludge appeared to be essential—the most common practice being to add it to the crude sewage. Sedimentation and thickening in the primary tanks, along with the crude solids, produced a mixed sludge of 90 to 92 per cent moisture content. A minimum of 2 hours settling was required in this method of disposal and in warm weather when employing this scheme septic action in the clarifiers created poor effluent and resultant difficulties.

To minimize poor conditions, created by overflow digester liquor, continuous return of excess sludge to primary clarifiers and frequent short period pumping of the mixed sludges to digesters had been very helpful. A novel scheme of sludge transfer was the automatic time control of operation of sludge pumps by a contact clock arrangement set to operate pumps for predetermined periods during each hour. The scheme developed at Los Angeles by Goudey and Bennett** and successfully employed since at the Phoenix, Arizona plant, for sludge thickening, appeared to be the most satisfactory, in that it concentrated surplus activated sludge in separate tanks. This scheme entailed the utilization of one final settling tank, or a separate tank, for settling and concentrating the sludge to be delivered to digesters direct. Mixed liquor entering this thickening tank from the aeration tanks received sufficient chlorine to hold the settled sludge in a fresh condition while concentrating it to 95 per cent or less water content. The process was continuous and sludge pumping at low rates was frequent if not continuous. The chlorine dosage at Phoenix had amounted to roughly 0.5 p.p.m. based on the sewage (not sludge) treated.

Discussing the practicability of treatment of overflow liquor Dr. Fischer considered disposal on sand beds to be a temporary expedient which was not practical as a routine process. Precipitation with coagulants had not been very satisfactory but 300 p.p.m. chlorine when added results in sterilization, bleaching and precipitation of solids. On the whole, return of overflow liquor to the crude sewage had been the most practical means of disposal—0.3 to 0.5 per cent solids being the maximum allowable in the liquor. The problem had been most acute at activated sludge plants. Chlorination of the liquor had proven helpful to check septic action in clarifiers and ill effects in aeration tanks.

Concerning digester operation, Dr. Fischer commented that temperatures of 70 to 95 degrees F. had been satisfactory, higher temperatures for thermophyllic digestion (130 deg. F.) had created trouble and inferior overflow liquor. He enumerated the several advantages to be gained by two stage sludge digestion—the first being accompanied by vigorous stirring and the second by mild thickening action resulting in a less turbulent condition and less solids in the overflow liquor.

WESTON GAVETT, Consulting Engineer, New York City, reporting on observations at small works, believed that return of supernatant digester liquor to the crude sewage was overall the most satisfactory procedure but

Morris M. Cohn, Elected Vice President and Recipient of Kenneth Allen Award

L. L. Luther, Voted the Kenneth Allen Memorial Award

recommended a low rate of continuous or almost continuous return. In some instances he had thought the scheme actually beneficial to activated sludge plant operation.

C. C. AGAR, Assistant Engineer, New York State Department of Health, presented a witty discussion of the supernatant liquor problem. It was his opinion that pre-concentration of sludge before delivery to digesters should become universally practiced; separate digesters should be not less than 20 ft. in depth, equipped with flexible supernatant discharge arrangements; sludge in-

**See WATER WORKS AND SEWERAGE, May, 1933—"A New Method of Concentrating Activated Sludge"—R. F. Goudey and S. M. Bennett.

put rates should be more controllable than heretofore. The whole complexion of sludge digestion practice and dewatering, at larger works, stood fair to be revised because of the newer vogue—vacuum filtration of sewage solids.

JOHN SKINNER, Consulting Engineer, Rochester, N. Y., felt that the much maligned two-story tank had advantages when one considered that there existed an automatic and gradual displacement of supernatant liquor from the lower chambers created by solids dropping through the slots.

H. HEUKELEKIAN, New Jersey Experimental Sewerage Station, New Brunswick, N. J., suggested return of as much as possible of the supernatant liquor during periods of off peak loadings on the plant. Such practice would entail night pumping or some form of liquor storage.

"The Results from Circulation of Sludge vs. No Circulation in Separate Digestion Tanks"—C. E. KEEFER, Engineer in Charge, Sewage Treatment Works, Baltimore, Md.

Mr. Keefer reported on large scale studies of the effect of circulating sludge by operating a Prüss pump in a covered coil-heated digester 38 ft. in diameter and 15 ft. deep which received crude solids. A twin digester, operated in every respect the same except that there was no sludge circulation, served as the control unit. The 50 per cent increase in gas production reported in Germany as being due to the operation of the Prüss sludge pumping scheme was found to be but 21 per cent at Baltimore. The observed degree and rates of digestion (based on residual volatil solids on a dry basis in the sludge) was approximately the same for both tanks, whereas, the pumping (circulation) produced a sludge of higher moisture content. The scum depth was reduced appreciably by the pumping which lifted sludge from the bottom and sprayed it over the surface of the tank contents. Heat losses from the two tanks were about equal—slightly less from the circulated sludge. The increased gas production (21 per cent) was the most noticeable difference produced by circulation—raising the per capita daily production of 0.62 cu. ft. to 0.75 cu. ft. The constituents of the gas from both tanks was approximately the same —the CO_2 content being roughly 32.5 per cent. The chief difficulty with the Prüss pump was the rope like obstruction which had been built up of hair and similar materials, and caused a breakdown by winding around the shaft and impeller.

DR. W. RUDOLFS, Director, New Jersey Sewage Experimental Station, New Brunswick, N. J., in discussion, said that intensive stirring or circulation of crude solids and digesting sludge was obliged to create improved digestion and reduced scum. Too intensive stirring was harmful and produced greater volumes of sludge per pound of dry solids because of increased moisture content of the sludge drawn off. He pointed out the fact that, what seemingly was an unimportant increase in percentage of moisture in the sludge drawn from the Baltimore tank equipped with the pump, the sludge handled from that digester had been 50 per cent greater by volume—an important consideration. Dr. Rudolfs reported, that in the Essen-Nord district (Germany) Dr. Prüss was building sludge "cathedrals" equipped with Prüss pumps—the structures were dome roofed and had a capacity of 77,000 cu. ft. of sludge. Believing that sludge stirring would be beneficial on the whole he felt that it must be properly done to avoid undesirable effects from too vigorous or too continuous stirring. The latest scheme of Dr. Prüss was to operate the circulating pump only at hourly intervals for approximately 5 minutes.

DR. A. J. FISCHER said, that to him a 21 per cent increased gas yield indicated increased digestion and greater recovery of gas values for power or heat production. In two stage digestion the moisture content of the sludge, transferred from the primary digester to the secondary digester, was not of consequence, and therefore a rapid stirring in the first stage was practical and beneficial.

HENRY W. TAYLOR, Consulting Engineer, New York City, said that sludge circulation to effect heat equalization in digesters in the colder northern areas was of importance. Without circulation there would be deep scum on the surface. A difference of 5 deg. F. between the top sludge and the scum was common. He thought a middle ground between rapid agitation and none at all should be considered.

Chemical Precipitation—Topic of Chief Interest on Afternoon Program

"Results from Six Months of Operation of a Small Chemical Precipitation Plant at Chicago"—G. H. GLEASON, Chemical Engineer, Guggenheim Bros., New York City.

At the January 1933 meeting of the Association, a paper was presented which described the Guggenheim process of chemical sewage treatment and set forth the results from a small experimental unit operated on New York sewage by the Guggenheim Laboratories. Visitors inspected a 50,000 g.p.d. plant then ready for shipment to Chicago for making further studies on the Chicago sewage at the North Side plant. It was the results from 6 months of continuous operation of this demonstration plant, that Major Gleason reported on.

Prof. Thorndike Saville, New York University

A. F. Dappert, Retiring President

The sewage, he said, was first subjected to chemical precipitation involving the use of a ferric salt (dosages averaging 28 p.p.m. iron) and small additions of lime. The effluent was then passed through zeolite beds to remove soluble basic compounds, principally nitrogenous. Lime added had been only that required (average 44 p.p.m.) to maintain a pH value of 7.6 in order to protect the zeolite and afford satisfactory sedimentation of precipitated solids. The dosage of ferric sulphate had been varied at times to compensate for changes in character of the sewage. The zeolite beds had been washed and then regenerated with brine solution every 24 hours. The greatest individual improvement made during the 6 months of operation under a variety of seasonal conditions, was the increase in sludge cake yield by the vacuum filter. The original 0.7 lbs. of dry solids per square foot per hour had been raised to 6 lbs. and better, the moisture content of the cake during the high yields being 75 per cent.

The disposal of sludge cake in a two stage incinerator involved drying it to an 8 per cent moisture content (without odors) in the first section and incineration to ash in the second section. The acid treatment of the ash to recover sulphate of iron for re-use had given no difficulties. The plant for recovering ammonia and regeneration of the brine had operated satisfactorily. Only one man on each shift had been required to operate the purification units in the plant while the operation of the iron and ammonia recovery units required one man for each, the work being done on the day shift only.

Major Gleason pointed out that the plant had been operated by workmen from the District's North Side plant and all samples had been taken under the direction of Dr. F. W. Mohlman and examined in the District's laboratories. The average B.O.D. reduction for the entire period had been 91.2 per cent—the minimum being 88.3 per cent and maximum 95.0 per cent. That had compared favorably with the 89 per cent average reduction by the large North Side activated sludge plant during the same period for which a minimum of 86 per cent and maximum of but 92 per cent was recorded. Removal of suspended solids had averaged 97.4 per cent as against that of 90.4 per cent by the large activated sludge plant. Removal of organic nitrogen averaged 79.3 per cent in the demonstration plant and 74.7 per cent by the activated sludge plant—the ammonia removal being 67.4 and 51 per cent respectively. Of the B. coli 97.7 per cent were removed by the Guggenheim process.

Major Gleason offered some figures to cover construction and operation costs of various sized plants from 3 to 100 m.g.d. capacities, if built under New York City or Chicago conditions. He cautioned, however, that such cost data was to be considered only in the light intended, for no general figure should be cited in view of the fact that costs of sewage treatment plants and operating costs were dependent on the variety of conditions to be met. The construction costs per m.g.d. plant capacity varied from $70,300 for a 3 m.g.d. plant to $30,250 for a 100 m.g.d. plant. Predicted operating costs, varied from $18.30 for a 100 m.g.d. plant to $36.84 for a 3 m.g.d. plant, whereas, capital cost (8 per cent interest and depreciation) varied from $6.63 to $15.40 per million gallons. Although the ammonia recovered would amount to 100 pounds per m.g. possible income from ammonia sales had not been considered, he said, in arriving at the above costs of operation—nor, had the heat from the incineration of sludge been given any value.

Langdon Pearse, Chief Sanitary Engineer of the Chicago Sanitary District, being unable to attend the meeting, discussed Major Gleason's paper by submitting a written statement read in his absence. Mr. Pearse explained that the comparison of the effluent from the North Side plant (activated sludge) and the Guggenheim plant effluent was not entirely fair. The large plant was not operating at its highest efficiency whereas the Guggenheim plant was being carefully attended. The removal or oxidation of the nitrogenous materials had been about the same for both plants but admittedly the Guggenheim process had effected a higher removal of suspended solids. The 5 day oxygen demand of seeded samples of the Guggenheim effluent had been 9.5 p.p.m. as compared to 5 p.p.m. on unseeded samples.

Mr. Pearse commented on cost comparisons by saying that power prices were not subject to the variations that chemical prices were and therefore a speculative element appeared in chemical precipitation processes. Of all such processes that had been offered to date, the Guggenheim process seemed to be the most complete, and, one capable of high efficiencies. He felt that large scale operations were now desirable to determine costs and settle questions of practical control of the process and its freedom from incinerator odors. Some caution should be shown in cost discussions when comparing this important feature with that of other processes. The future of the process hinged on first cost, the feasibility of recovery of ferric salts from the incinerator ash, recovery of ammonia and royalties to be charged. Mr. Pearse closed with congratulations to Major Gleason and other Guggenheim authorities who had developed and demonstrated the process.

Wellington Donaldson, Consulting Engineer, New York City, said that it was quite valuable to have available the impartial analytical results comparing the effluent from a large and well operated activated sludge plant with the Guggenheim plant effluent for a six month period. The better removal of suspended solids, appearance of effluent and the somewhat greater oxygen demand and organic nitrogen removals revealed an appreciable and consistent superiority of the process over the activated sludge process. The questions of costs of structures and operations can not be definitely settled until a practical scale plant is constructed and operated but, in the meantime, the figures presented by Major Gleason must stand as a challenge when considering compactness of structures, completeness of treatment and freedom of odors. He wished to congratulate Major Gleason on the methods employed in projecting the enterprise—to wit, the development and publication of facts prior to exploitation of the process.

Asher Atkinson, City Engineer of New Brunswick, N. J., Since 1891, *a Regular Attendant of the Association Meetings*

Alexander Potter, Consulting Engineer, New York City, considered the practicability of obtaining a degree of purification superior to the best biological process (activated sludge) an important contribution to the art of sewage treatment. The fact that chemical processes (supported by his observations at Atlanta and Philadelphia), operated satisfactorily with radical variations encountered in sewage character, was a point of very practical meaning to one familiar with the ill effects of variations in sewage character on biological processes. As to sludge volumes, 1,770 lbs. of dry solids yield per M.G. compared with 1,965 lbs. produced at Atlanta where the average suspended solids had been 159 p.p.m. as compared with 133 p.p.m. at Chicago. Such moderate sludge volumes were quite different from the 3,000 to 4,000 lbs. per M.G. expected from the older precipitation processes. Furthermore, when compared on a volume basis, the activated sludge process produced 6 times the volume of sludge to be expected from modern chemical precipitation—the chemical sludge being a character more amenable to economical disposal than the biological sludges. Mr. Potter felt that there was a wider application for a process giving an intermediate and less costly treatment and he would be interested to learn from Major Gleason what purification had resulted when less complete treatment was given. He stressed the flexibility of the chemical process for meeting seasonal demands in respect to degrees of treatment and also for dealing with difficult wastes and sewages.

Major Gleason, in reply, stated that the effluent when by-passed around the zeolite filters would contain about

20 p.p.m. suspended solids but the oxygen demand reduction would average 80 per cent. In reply to other questions, he said, that in computing the reported net costs for treatment, nothing had been credited to the ammonia recovered. The required ground area for a plant would average 2,400 sq. ft. per m.g.d. plant capacity. As to the reducing of the dosage of chemicals the oxygen demand reduction was less affected than the appearance of the effluent.

E. T. KILLAM, Consulting Engineer, New York City, basing his remarks on recent experiences, said that it would have been interesting to compare the performance of the chemical process with that of a smaller biological plant. From observations he had found efficiencies of small activated plants much more erratic and of a lower order than that reported for the large Chicago plant. That 80 per cent B.O.D. reduction could be attained without filtration, was not out of line with his experiences with chemical precipitation but he felt that a filter of some sort was justified on the score of improving appearance of effluents. The ability to vary the performance of chemical plants all the way from plain sedimentation up the scale to 80 or 85 per cent complete purification had a distinctive practical and economic aspect.

"Selection and Utility of Porous Diffuser Plates and Holders"—ANDREW B. HOLMSTROM, Norton Company, Worcester, Mass.

Mr. Holmstrom in discussing the selection of porous plates and holders for air diffusion, stated that the ease with which plates could be removed from the tanks for cleaning was a highly important consideration. The trend was distinctly away from the fine grained plates for activated sludge plants. The pore size of plates with a rating of 40 cu. ft. per min. per square foot was only 0.3 m.m. diameter as compared with the 0.21 m.m. size of pores in plates having a 20 cu. ft. rating. Pressure losses through 40 cu. ft. plates, however, were less than half that for 25 cu. ft. plates. Plates with a rating of 50 cu. ft. would be used in some cases and Chicago and Indianapolis were already using 35 cu. ft. plates.

In discussing types of plate holders, Mr. Holmstrom described the advantages of the new plate holders of aluminum which have been perfected by the Aluminum Company of America. He also referred to a novel type of plate holder, which had been designed for the Durham, N. C., plant by Wm. B. Piatt, to set in a vertical position and emit air horizontally in two directions.

FRANK C. ROE, Engineer, Carborundum Company, Niagara Falls, N. Y., said, that the chief value of the coarse grained plates was the less likelihood of clogging and reduction in power consumed. The larger size of bubbles had not reduced the efficiency of aeration to any practical extent. On these three scores the more porous plates and tubes were being prevalently specified. Tubes were favored by many on account of their ease of removal from the tanks for inspection for cleaning. Mr. Roe also outlined the various methods of installing plates in plate holders.

W. R. COPELAND, Chief Engineer, Connecticut Board of Water Purification, discussed the relationship between depth of tank, size of bubbles, pressures and speed of travel upward and their bearing on efficiency in aeration practice.

"The 'Why and How' of Sewage Research in New York State"—PROFESSOR THORNDIKE SAVILLE, New York University, New York City.

Professor Saville outlined the plans of the Association Committee on Research, of which he is chairman.

Among the proposed work of the committee was the recording and analyzing of existing sewage facts; trying and developing new processes; evaluation of patented processes offered; stream studies; true research. The list of problems cited loomed large. Among the important ones was a study of the effect of industrial wastes on the various treatment processes looking to a means of correcting such difficulties. The disposal of supernatant liquor from sludge digesters was another.

PROF. EARLE B. PHELPS differentiated between experimentation, frequently spoken of erroneously as research, and true research. He believed that studies of fundamentals were highly desirable.

DR. RUDOLFS remarked that the scope of the program sounded rather broad. Speaking from experience during the past 12 years, he would recommend concentration on selected problems, fewer in number.

Harry E. Jordan Next President of the A. W. W. A.

H. E. Jordan

Being the single nominee to the presidency of the American Water Works Association for the year 1934-1935, Harry E. Jordan, Chemical Engineer and Superintendent of Filtration, Indianapolis Water Company, is to be the next president of the Association.

Mr. Jordan, except for a period of World War Service in the U. S. Army, has been connected with the Indianapolis Water Company continuously since 1903—the year of his graduation as a budding chemist from Franklin College. Starting in the laboratory in 1903, his present position as Superintendent of Purification was created in 1911. He has served well, the association of which he is to become president, for a number of years. In 1923 he was chairman of its Water Purification Division and in 1925 took over the burdensome secretaryship of this division, which he has filled continuously since. He served as chairman of the Indiana Section of the Association in 1924 and since 1931 has served this Section as its representative on the Board of Directors of the National Association. He accepted, in 1932, the difficult job of leading the Joint Editorial Board of the A. W. W. A. and A. P. H. A. of the Manual of Standard Laboratory Practice—otherwise known as "Standard Methods." And, he has served the Association in several other and important matters.

Mr. Jordan is the 4th official of the Indianapolis Water Company to be honored by the presidency of the A. W. W. A., Frank (no relationship) C. Jordan, now Secretary of the company, having been the most recent (1924-1925) to serve. Carlton E. Davis, now manager of the Philadelphia Suburban Water Company, was President in 1920 and F. A. W. Davis (deceased) in 1896.

Well, Harry, this being 1934, we all toast the President-Elect in a manner appropriate—with liquids as legal as water. Here's to you: You have won your spurs!

ARTESIAN WELL, 2,728 FT. DEEP.—An artesian well 2,728 ft. deep has been bored at Aulnay-sous-Bois, near Le Bourget, France, the Paris airport, to supply drinking water to the north-eastern districts of the city. The work was completed in the remarkable short time of four months.

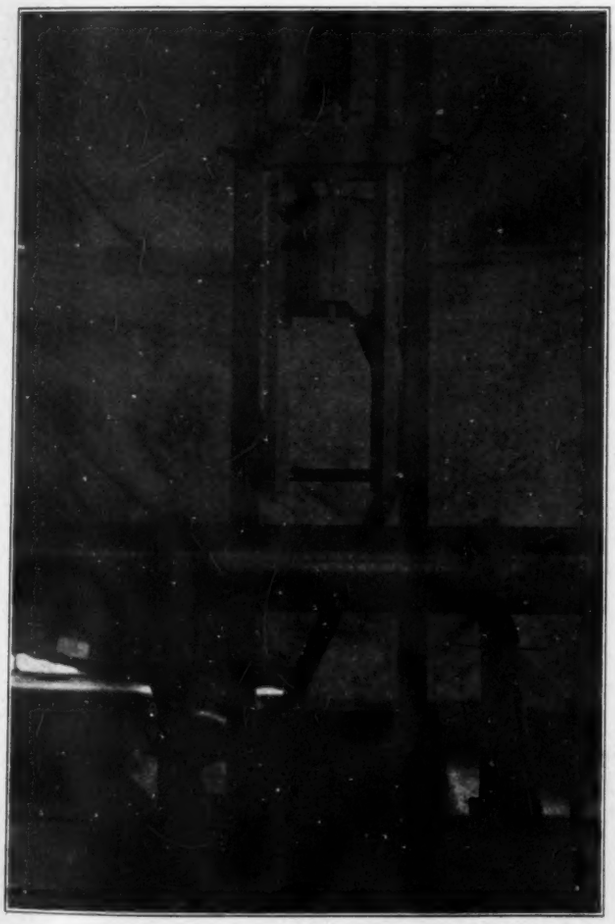
WHAT IS SUPER-DE LAVAUD PIPE?

WHAT is Super-DeLavaud Pipe? . . . It was this question that took about twenty editors and newshawks, representing the technical press, to the Burlington, N. J., works of the U. S. Pipe and Foundry Company on the 24th of January. There they saw something new in cast-iron pipe manufacture—an improved process of centrifugal casting productive of "shatterproof" pipe, with its resistance to impact toughness increased manyfold.

Manufacture of centrifugally cast pipe by the DeLavaud process of spinning the molten iron into pipes in rapidly revolving water-cooled metal molds, was introduced in America in 1922. Production of pipe by this process during the ensuing years approximates 85 million feet. The uniformity of wall thickness, density of structure and increased tensile strength of centrifugally cast pipe were the chief points of its superiority over pit cast pipe and permitted production of thinner walled and a less expensive cast-iron pipe.

The products had one shortcoming, a limited resistance to impact; a condition shown to have been caused by the rapid chilling of the molten iron at its point of contact with the water-cooled mold. Because of this and other considerations, it was the opinion of a forward-looking Board of Directors of the U. S. Pipe and Foundry Company that a Research Department should be established and manned with a staff qualified to study pipe manufacture and evolve means of improving the production and quality of cast-iron pipe. And, even in the face of the depression, a research laboratory was equipped and manned in 1930.

The Impact Tests Under Way. Scrutinizing Editors Watch Closely for the Appearance and Nature of Ruptures from the Maximum Hammer Drop.



Machine Used for Impact Tests. (Machine and Test Were Developed by U. S. Pipe & Foundry Co.)

One of the first aims of the new research department was that of overcoming damage resulting from rough handling of pipe in transit and in the field—a problem which faced all manufacturers of cast-iron pipe. Methods were sought for toughening the pipe in order to increase its resistance to impact, i. e., the production of a "super-pipe" with shatter-proof qualities heretofore unattained.

Value of Research Demonstrated

How well the research and development engineers and chemists, working under the direction of Dr. F. C. Langenberg, have attained its aims, lies in the answer to the question—"What is *super De Lavaud* pipe?" To best answer that question the production and resistance tests applied to the product was demonstrated to representatives of the technical press on January 24th.

Lectures and demonstrations, by Dr. Langenberg and staff members of the Research Department, revealed that a patented process, entailing the use of a small quantity of a finely ground powder to produce an insulating film of spider web thickness on the interior metal surface of the centrifugal mold, had proved to be effective in retarding the chill of the pipe sufficiently to produce a marked toughening of the metal structure. No change whatever had been made in the metal composition or in its preparation prior to molding. In a nutshell that constitutes the whole story, which is as simple as it sounds—provided one knows how to apply that film, and what material to employ.

Having established the fact that the scheme was workable, the selection of the most suitable powder and the evolution of the most practical method of application entailed extensive experimentation and numerous cut and try procedures.

A Moment of Discussion Between Tests.

a narrow blunt edge at its center contact with the pipe, was trigger dropped onto the pipe repeatedly. Starting

The Anti-Chill Process

The process as finally established involves the use of a pulverized iron alloy. The finely pulverized alloy is fed from an accurate and specially designed dry-feed machine into the intake of an air blower which delivers the air powder stream through a pipe line to a jet nozzle of ingenuous design. This nozzle is located at the front end of the travelling spout which discharges the molten iron into the revolving pipe mold. It is so placed as to apply the thin film of ferro-alloy dust in a ribbon just barely ahead of the closely following ribbon of molten iron. The same centrifugal force holds the powder in place that uniformly spreads and holds the fluid iron in place against the mold. The theory in explanation of the anti-chill effect is that the powder absorbs a small amount of gas (air in this case, but other inert gases serve as well) which is tremendously expanded when the molten iron strikes: And, thus, the iron rides on a blanket or cushion of gas which serves as an efficient insulator against instantaneous chilling. The intriguing feature of the process is that it does the job so simply and inexpensively.

Regardless of the explanation, the whole amount of powdered ferro-alloy (200 mesh and finer) required, for an operation which turns out an 18-ft. length of 12-inch pipe, is but 8 ounces—only about three-fourths of a drinking glass full. To insure even distribution of so small a volume over the mold wall area to produce a proper thickness was not a simple problem.

Further improvement in the pipe has resulted from development of a newly improved and patented annealing process, insuring uniform heating completely across the annealing oven by electrical thermo couple control. In this process a lower temperature and longer period of annealing is provided than was true of the process superceded.

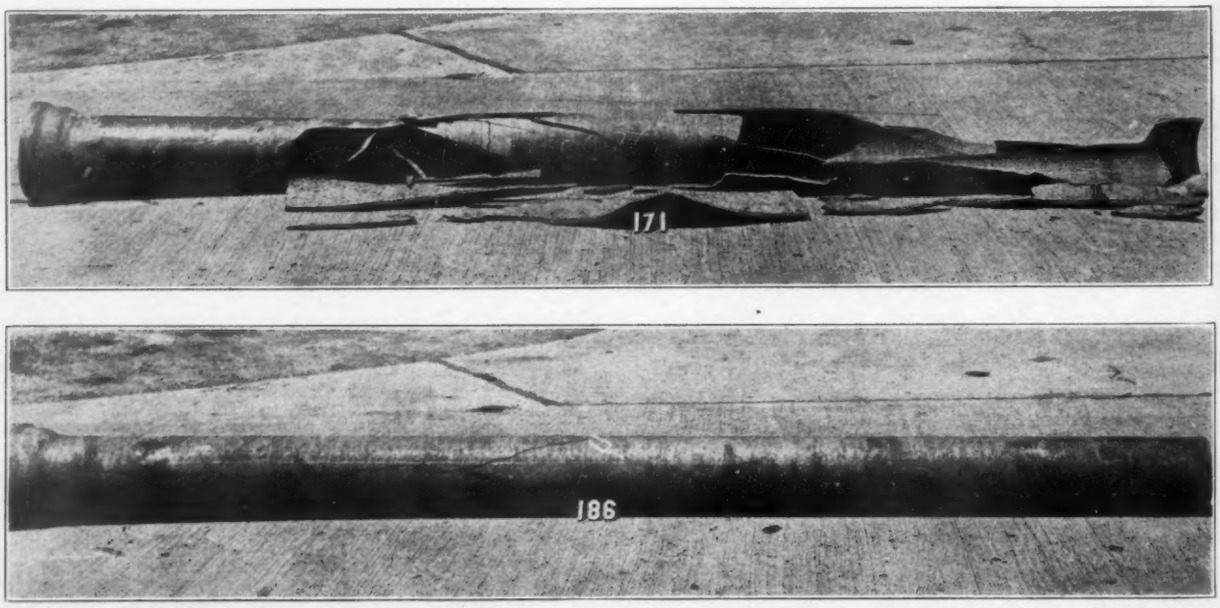
A Marked Change in Metal Structure

The question—Why does slow chilling create a tougher and more ductile product?—is answered, not by any change in chemical composition, but, by a marked change in the nature of the molecular and crystallographic arrangements of the pure iron within the walls of the pipe. Microscopic examinations looking into the metallographic structure of the rapid chilled ordinary DeLavaud pipe, in comparison with slow chilled Super DeLavaud pipe, show marked differences. The more brittle structure of the outer half of the wall thickness of the old pipe no longer appears. Instead, a dendritic (tree-like) structure with branches like those on the fir and balsam, interlocking as in a dense forest or thicket, is found to exist. These "tree branches" of pure iron, as might be expected, make for toughness of the metal. It is also this fibrous iron structure which accounts for the new pipe being 62 per cent more ductile, 100 per cent more shock-proof and considerably more amenable to drilling, threading and machining.

Improved Characteristics of the New Product

The outstanding improvement is the greater resistance of the new pipe to rupture created by shock.

The standard test of such resistance, developed by the U. S. Pipe and Foundry Company, was demonstrated in order to reveal the difference between DeLavaud and Super-DeLavaud pipe. A section of pipe was filled, and kept under a 65-lb. water pressure. It was clamped at points two feet apart and at the center (1 foot from each support) a drop-hammer, weighing 50 pounds and having



8-in. DeLavaud Pipe Tested to Failure by Internal Water Pressure. (Above, Standard DeLavaud. Below, Super-DeLavaud)

with an initial drop of 6 inches the height was increased 2 inches with each succeeding blow, the hammer striking the same point at each trigger pull. As the drop was increased a hair crack appeared. Then, on further increasing the drop, the crack began to "weep" and eventually the pipe failed and water gushed through.

In the duplicate tests witnessed on January 24th the first crack and first "weep" were simultaneous on the old pipe at a drop of 2.83 ft. and the pipe failed at the 3-ft. drop in one test and at 4.33 ft. on another. The "Super" pipe showed a hair crack at 2.83 ft. also, but no "weeping." To bring about failure of the new pipe the maximum hammer drop of 5 feet was reached and had to be repeated on one test 6 times and on another 11 times, revealing an impact resistance considerably above the 100 per cent increase over the old pipe which the improved process is claimed to produce.

Perhaps the most interesting aspect of the test to this observer, was the difference in the nature of the ruptures. On the old pipe a single long crack or rip appeared suddenly and extended far on each side of the hammer, whereas, the cracks in the improved pipe were radial (spider like), jagged and short. After "weeping" had started it looked as though the repeated hammer blows were healing the "wound" as rapidly as it was spreading it and gushing was spotty and mild—more of a boiling. Greater malleability of the new pipe was clearly in evidence in these tests.

On bursting a pipe with hydrostatic pressure the new pipe actually tears or rips open and does not shatter as is the case with the old DeLavaud pipe with its outer shell of crystalline structure (see illustrations).

Asked about the cutting qualities of the improved pipe—the reply was, that lined pipe could be cut more easily and with less danger of damage to the lining than was true of the more brittle pipe. Further, the machinability of the new pipe was reported to compare favorably with that of grey iron castings.

As the old saying goes, "seeing is believing." Such demonstrations as those witnessed by the writer at Burlington, N. J., backed by statements of actual users of the pipe during 13 months of experimental production, makes doubly impressive, this material and fundamental improvement in cast-iron pipe manufacture.

The value to industry of applied research and vision of executives, who have the ability of looking ahead, has been again demonstrated in a very real manner by U. S. Pipe and Foundry Company.

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New Device for Hauling and Dumping Dried Sewage Sludge

Designed for Springfield Sanitary District

By W. B. Walraven*

AT sewage treatment plants using sand drying beds, the removal of the dried sludge presents a troublesome and almost continuous problem. At the different plants the mechanics of removal vary considerably. Some plants employ trucks which run upon fixed or movable runways while others use industrial railway equipment. A few, particularly the very largest plants, have tried the development of specially designed sludge stripping mechanisms.

At the sewage treatment plant of the Springfield Sanitary District, sludge was until recently removed in trucks which ran upon tracks composed of heavy oak planks. The placing and removal of these planks entailed a considerable amount of labor and were not altogether satisfactory. Sometimes the trucks ran off the planks with the result that the sand beds became badly cut up.

We made estimates comparing the cost of fixed runways of concrete or steel channels, and of industrial railway equipment, and had almost decided to build fixed steel tracks, when an entirely new idea was presented.

The Allis-Chalmers Mfg. Co., which maintains a tractor plant at Springfield, suggested a crawler-type tractor upon which side dump sludge bins could be mounted. The technical problems involved are many and quite interesting to tractor designers, although we were interested only in the final outcome. After a few weeks' study of the problem, the chief engineer of the A.-C. Tractor Division, offered designs for bins to hold two and three-quarters cubic yards of sludge, equally divided between the two sides, and provided with dumping levers which can be operated from the driver's seat.

The superimposed load added to that of the tractor

Utility Tractor Equipped with Sludge Removal Gondola, Designed by Allis-Chalmers Mfg. Co. for Springfield's Sewage Treatment Works

results in a uniform pressure of ten pounds per square inch under the surface of the crawlers in contact with the sand. The loading edges of the bins are about 3.5 ft. above the sand.

Our experience with the machine has been satisfactory, and we were particularly pleased to note that the crawlers cause very little disturbance to or compacting of the sand bed. Due to the extreme mobility of the tractor it can be placed within easy loading distance, with the result that we now are able to clean a sludge bed in much less time than was formerly required. We have found that the bins dump the load freely. The sludge being dumped forms windrows on either side of the tractor. When the disposal area is filled, the tractor is run on top of the sludge and windrows are started at a higher level.

In the design of the mechanism, the Sanitary District required that the bins be easily removable, so that the stripped tractor might be available for other purposes around the plant. Shortly after the unit was purchased, we had occasion to build an earth levee, in the construction of which the tractor played an important part. We found that three laborers required about thirty minutes for the removal of the bins, and slightly more time to install them on the tractor again after the levee was completed.

We believe that this new device will find a wide application and will probably supplant most of the methods heretofore commonly employed in stripping sludge from drying beds and transporting it to the dumping areas.

*Engineer, Springfield Sanitary District, Springfield, Ill.

MEETING OF SANITARY ENGINEERING DIVISION OF THE A. S. C. E.

IN the meeting of the Sanitary Engineering Division of the American Society of Civil Engineers in New York City on January 18th, the following papers were presented:

"On the Flow of Water Through Sand"—PROFESSOR GORDON M. FAIR, Harvard University, Cambridge, Mass.

Professor Fair reported in abstract on extensive and fundamental studies of the behavior of sand beds in relationship to loss of head during filtration and bed expansion during washing. In this work new formulae for calculating predicted losses of head and expansion of bed have been developed, which take into account ratios of "volume to shape" and "area to volume" of the sand grains. The Hazen formula for loss of head in sand beds, having been developed for unstratified sand with a high uniformity coefficients, was satisfactory under such conditions but not so for the stratified beds in rapid filtration practice. Therefore, studies had been undertaken to develop the new loss of head and expansion formulae, the various factors of which Professor Fair analyzed. He showed that there would be a distinct variation of expansion for round or worn sand; of sharp bank sands; and, angular beach sands—the expansion varying as the square of the area-volume ratio. He showed that the loss of head through clean sands became less per foot of depth as the uniformity coefficient increased i.e. uniform grain sizes produced higher loss of head in a given depth than non-uniform sands.

FRANK W. HERRING, Associate Editor, Engineering News-Record, New York City, pointed out the fact that the formulae developed by Professor Fair, in addition to sands, applied to all other porous media as well. Stratified rapid filter beds were in reality a series of filter beds, with the finest grained at the top—each stratum having a high uniformity of grain size. The development of "factors of permeability" constituted an outstanding contribution. To put filter sand specifications on a rational basis Mr. Herring thought that it would be necessary to consider several factors in addition to loss of head and sand expansion characteristics—the character of floc being perhaps the most important of the factors. Selection of sands would be based on two major considerations—economy of operation as against safety. The first would come through the use of large grained sands, whereas, the second put a limitation on the porosity of the bed and favored smaller sized grains.

ROBERT E. HORTON, Consulting Engineer, Albany, N. Y., considered the work of Professor Fair as of fundamental importance since it would apply to hydraulic flows through porous soils as well as sand beds and the contribution would prove to be of considerable engineering value.

PROFESSOR FAIR, in closing the discussion, said that a question raised in his mind was—Are we doing the right thing in using non-uniform sands in filters? Why shouldn't coarser sands of a high uniformity of grain size be specified, with appreciation that the whole depth of bed would then become effective in filtration practice.

"Underground Corrosion"—K. H. LOGAN, Chief Underground Corrosion Section, Bureau of Standards, Washington, D. C.

In Mr. Logan's absence his paper was read by Leonard P. Wood, of the N. Y. Board of Water Supply. The paper stated that there were 450,800 miles of trunk water pipe lines in the U. S. and that corrosion losses could be estimated at roughly 75 million dollars annually. Studies of corrosion of water mains dated back to the work started in 1927 by the Cast Iron Pipe Research Association. In soil corrosion, unevenness of attack was the important consideration and usually the bottom of the pipe suffered from corrosion more than did other parts. Differences in the electrical potential in the metal was another important factor. Studies by the Bureau of Standards had indicated that the "pattern" of corrosion was determined by the type of soil rather than the nature

Prof. Chas. Gilman Hyde, New Chairman of Executive Committee and the Division

H. Burdette Cleveland, New Secretary of the Executive Committee

of the metal. Many factors, such as oxygen supply and acidity of soil, had a bearing. But, the electrical conductivity of soils (indicating moisture and salt content) had proved to be important and the most practical index for predicting corrosivity characteristics of soils. To reduce corrosion losses, soil surveys, involving conductivity tests, would reveal the need of localized pipe protection where most necessary. Selection of pipe materials was next in importance—copper and its alloys being universally more resistant than iron and steel. Thickness of the pipe wall was probably more important, from a practical angle than employing thinner but more resistant materials. For continued long time protection, protective coatings, such as used in the past, had a questionable value in Mr. Logan's opinion. Improved coatings were being developed to effect greater durability and dependability.

He showed that increasing the wall thickness of pipe by 40 per cent, extended the useful life of the pipe from 14 years to 27 years. Coatings added had been equivalent to a 13 year extended life to pipe and therefore, even assuming a breakdown of the coating, an additional cost of 10 per cent to cover the expense of coating was justified. Bituminous coatings had failed due to pinholes or blisters and puncture during pipe laying and therefore the application of a reinforcing cover over bituminous coatings was advocated. Mr. Logan referred to the value of an electric method (spark jump) now used on pipes at the trench side to detect faulty (leaky) coatings before laying.

Discussions by John R. Baylis and Thomas H. Wolfe (by letter) were presented by title only.

In reply to a question, as to merits of steel vs. wrought iron, Mr. Wood replied that in general observations had not indicated one to be preferable to the other. Soil quality would determine the selection of material.

JOHN R. SKINNER, of Rochester, reported an observed superiority of wrought iron mains over steel at Rochester and where coatings had been punctured the protection had been good for 10 years only.

"Report of Committee on Water Supply Engineering"—THOMAS H. WIGGIN, (Chairman) Consulting Engineer, New York City.

The most interesting and illuminating of the committee reports was that presented by Mr. Wiggin. It constituted a review of recent developments in water supply engineering and the evaluation of equipment and practices introduced during recent years.

Particular engaging advances, he said, included such developments as the drawing up of individual specifications for cements to be employed on specific projects, rather than adhering to standard specifications previously considered satisfactory for good cement. Limits had been set on heat production during cement hydration and hardening of concrete in dams and other massive structures. Such limits had entered the specifications drawn for cement used in the Pine Canyon Dam at Pasadena and the Boulder Canyon Dam. In placing concrete (0.95 bbl. cement to the cubic yard) internal vibrators had been effectively used on the dam for Pasadena. The cement water ratio used was 1. to 1.68 resulting in a "slump" of but 1 inch or less. Concrete shrinkage to completion had been hastened in the Boulder Dam by circulating cooling water through steel pipes embedded in the concrete—such being spaced about 5 ft. 9 in. (center to center) throughout the mass of concrete.

Concerning trends in steel pipe usage, he referred to the general acceptance of fusion (plate or strip) welding in shop and field to produce a pipe with a smooth waterway and, also, the use of combinations of fusion welding and sleeve couplings of the Dresser type for jointing. Examples had been the 30 in. line at Tamaqua, Pa., and the 78 in. line for Seattle. Spiral welded steel pipe had come into the market recently and had shown good qualities on test.

In the cast-iron pipe field the trend had been decidedly toward more universal use of centrifugally cast pipe.

"Transite" pipe of cement mortar and asbestos represented a new material in American practice, designed to resist internal corrosion and soil attack. The largest installation had been that at Winnipeg—2,400 ft. of 14 and 18 in. size being laid. It was being experimentally tried at other points also.

Cement lined C.I. pipe, with or without a coating of bituminous material to prevent leaching of salts and hardening of the water, had come into more general use to maintain the high initial capacites of new pipe. Steel pipe had been bitumastically lined and protected outside with a combination of reinforced mortar wrapping or gunite to give a combined thickness of 2 in. Notable examples of machine lined and machine wrapped fusion-weld pipe had been those of San Francisco and Seattle—56 to 78 in. steel pipe being thus protected. Bitumastic linings centrifugally applied to steel pipes in the field had been used on the Tamaqua, Pa., the Seattle and Washington, D. C., projects. The same practice has been followed by the Washington Suburban Sanitary District for lining cast iron sewer pipes; at New Haven, Conn., Newark, N. J., and Newton, Mass., for water pipe.

A method of testing for bituminous coating imperfections in the field, involving the use of high potential current placed on the pipe and a spark detector which travels along the pipe, had been recently developed. Using the tester a pipe could be insured as being free of leaks and pinholes in the coating just before lowering it into the trench—a valuable last rite before final interment.

In taste and odor removal from waters, activated carbon used in combination with chlorination seemed the most dependable method available. Carbons varied in their activity and adsorption capacities and therefore must be considered on this basis when making selections. With prechlorination to destroy tastes, the work of the carbon was facilitated and the required amounts reduced. Bleaching clays for adsorbing and removing tastes and odors had not proved their value. Their chief value was that of a floc increasing material and only incidentally that of taste and odor removers. Improvements in chlorination, with and without ammonia, had continued. The wide usefulness of prechlorination in heavy dosages has been proven in recent installations. The determination of residual chlorine had become complicated by the introduction of ammonia and a new technic was in process of development.

In settling (coagulation) basins slotted cross baffles had been effective for improving displacement and improved sedimentation.

Concerning improvements to pumps and prime movers the report directed attention to the increased efficiencies of centrifugal pumps and motors within very recent years. As the result of keen competition by manufacturers, a 90 per cent efficiency in centrifugal pumping is now available, whereas 80 per cent was considered high only a few years ago. Better hydraulic design of impellers and casings, together with increased driving speeds of prime movers, had been primarily responsible. Elimination of close clearances had meant design characteristics which maintain their high efficiency values in pumping—not easily lost by wear. Recent bids on 6 centrifugal units of 50 m.g.d. each for Chicago named guaranteed efficiencies of not less than 91.5 per cent. As to electric motors; synchronous motors are now prevalently used in sizes above 100 h.p. and efficiencies have been generally increased—one bidder guaranteeing a 98.41 per cent efficiency of 1,500 h.p. synchronous motors for Chicago. Recent tests elsewhere have shown 96.5 per cent efficiencies for 350 to 650 h.p. synchronous motors.

The use of Diesel engines for horsepowers below 400 had been on the increase, indicating a growing recognition of the economy and reliability of this type of prime mover. The perfections to high-speed steam turbines appeared to be the outstanding development in steam pumping during the past few years. The result is that these efficient and low cost drivers are now installed almost exclusively in steam plants requiring more than 200 h.p. Flexibility of operation was superior to motor drive and closely approached that of steam pumps.

Mr. Wiggin pointed out that improvements on check valves had been notable during the past few years. The ordinary swing check, while cheap in first cost, was dear in operating and maintenance costs because of friction, leakage and water hammer. The cone type of free-opening and gentle closing check had been a particularly valuable addition; had reduced water hammer and lowered operating costs. This statement was backed by his own experiences.

As to flow measuring devices; a 10 ft. Parshall flume utilizing the principles of a Venturi meter had been installed at Providence, R. I., indicating that this structure was beginning to find application in the water works and sewerage field as an economical and accurate measuring device.

Tests conducted to evaluate losses of head in bends,

tees and crosses on distribution and trunk mains had revealed that losses from such fittings are in general very small and there was no real advantages to be gained from the use of wide sweep bends or tees and crosses with smoothed out corners.

The report contained reviews of the work of various important committees such as that of the A. S. A. Committee on C. I. Pipe, the A. S. C. E. Committee on Irrigation Hydraulics which dealt with evaporation, scouring below dams, water movement under dams and silting up of reservoirs. Mr. Wiggin called attention to a tendency, growing out of the depression, to change established methods of utility valuation, depreciation and rate making and this subject should be given attention by the A. S. C. E. Committee on Valuation and Depreciation Procedures.

Other Committee Reports

Other reports read in the absence of the chairman was that of the Committee on Filtering Materials (W. E. Stanley, Chairman) and that of the Committee on Salvage of Sewage (A. M. Rawn, Chairman).

The final report on filter sand studies, expected within the year, will show the importance of water quality as a factor in arriving at specifications for appropriate sand for rapid filtration. As to sprinkling sewage filter efficiencies and determination of limits of loading, the committee questions the practice of depending on B.O.D. tests as the yard stick for evaluating the work of filters on the determination of loading limits, feeling that there were other and important aspects to consider.

The report by Mr. Rawn outlined the program set up, and in part already under way, to establish the practicability and limitations of salvage of water from domestic sewages. Reclaimed sewage water for industrial supply and irrigation appeared most immediately feasible. The cost, the requirements of quality and the fertility values of effluents would all receive study. Possible reclamation of sewage water for domestic supply would receive study from the standpoint of possible public health effects and costs when compared with those of obtaining new water under various circumstances.

New Officers

The following were elected new officers of the Division:

Chairman of Executive Committee and Chairman of the Division—Professor Chas. Gilman Hyde, University of California, Berkeley, California.

Secretary of Executive Committee—H. Burdette Cleveland, Cons. Engr., New York City.

New Member on Executive Committee—Chas. W. Sherman, Cons. Engr., Boston, Mass.

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Myron Borland Reynolds

With the passing of Myron B. Reynolds in his 53rd year, at Maywood, Ill., on January 27, 1934, the city of Chicago lost a faithful servant and an efficient City Engineer.

With the exception of two brief periods, while on leave of absence, Mr. Reynolds served the city from 1907 until the time of his death. He was born at Pana, Ill., in 1880; was graduated by Armour Institute in 1906, as Bachelor of Science, and in 1908 he earned the degree of Civil Engineer. With the city, his ability was early recognized; his promotion rapid. In 1913, at the age of 33, he was made Engineer of Water Works Design and was placed in responsible charge of the design of extremely important projects of the water works system of Chicago. The Wilson Avenue Tunnels and intake crib, costing $3,900,000; Mayfair Pumping Station; Lake View Pumping Station and the Western Avenue Tunnel were the more important of these. He was in charge of highly important studies of the hydraulics of water flow through large tunnels and formulated plans for modernizng the older pumping stations by substituting motor and turbine driven centrifugal pumps for the cumbersome triple expansion pumping engines.

From September, 1917, to January, 1919, he served as Captain and Major in the U. S. Army Corps of Engineers, after which he returned to the city's employ. In 1923 he was selected by John Ericson (the city Engineer) as his first assistant and was given the full title of Assistant City Engineer in 1925. Upon Mr. Ericson's death in 1927, Major Reynolds became Acting City Engineer and in 1931 was given the full rank of City Engineer—the highest position in the engineering service of the city.

He will remain well known as Assistant and later City Engineer because of his work in modernizing Chicago's complex water works system and in getting under way experimental filtration looking toward the design of filtration plants for the city. He lived to see his program of metering (always unpopular in Chicago) and plans for the first filter plant, together with applications for PWA loans and grants of $22,400,000 for the projects, approved by the City Council in December, 1933. This is perhaps the greatest exhibition of courage in facing political disfavor that has occurred in recent years and its outcome has established the high regard with which the political factions held the opinons and ability of Myron Reynolds as engineer and man.

Mr. Reynolds was a member of Tau Beta Pi engineering fraternity, the American Society of Mechanical Engineers, the American Water Works Association; was Commander of Castle Post of Professional Engineers in the American Legion and was a member of other professional societies. Only a short time before his death he received the Illinois Society of Engineers' Medal of Award, for 1933, as the senior author of a paper on "Chicago's Water Pollution Problem—Past, Present and Future."

Mr. Reynolds served as Chairman of the 1927 and the 1933 Chicago Convention Committees of the American Water Works Association, which took charge of arrangements for these two conventions of the Association. It was through his efforts, with the able assistance of Arthur Gorman, that these conventions were so successful. He was also responsible for the placing of placques to the memory of his famous predecessors—City Engineers Chesbrough, Cregier and Ericson—at the base of Chicago's historic water tower during the 1933 convention.

Major Reynolds' influence on men, and in matters of engineering policies, will be carried for many years in the Bureau he and his illustrious predecessors so ably directed. In the last years of his life he fought against odds and poor health which would have much earlier overcome most men of greater vigor. There is a vulgar but highly expressive term for such fortitude—*guts*. It was this characteristic, backed by ability, that carried Myron B. Reynolds to the success he so richly deserved. His name will be added to those which appear on the placques at the base of this monument to men responsible for the development of Chicago's Water Works System. What more fitting monument could there be to these, than is the artistic, historic and secure—"Old Water Tower"—dear to the hearts of all Chicagoans, and admired by all?

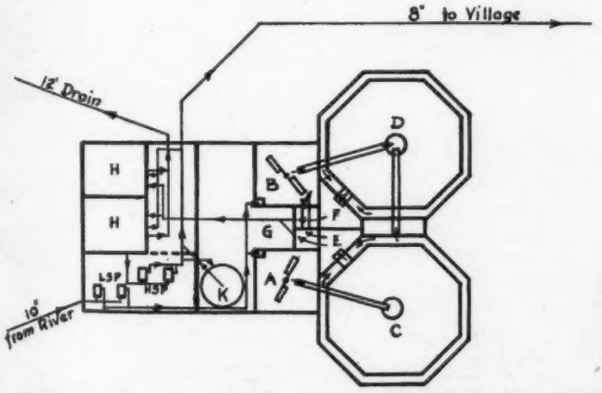
HANDLING SUGAR BEET WASTES IN A MUNICIPAL WATER PLANT

By W. D. LOREAUX

Superintendent, Water Works, Dundee, Mich.

THE Dundee, Mich., Filtration Plant uses the lime-soda process for softening, with additional equipment for treating the raw and semi-finished water with alum, activated carbon, carbon dioxide, ammonia and chlorine.[1] The raw water supply is taken from the River Raisin which for the most part drains rural territory. There are few industries that deliver wastes into the river. The most notable exceptions being a paper mill at Palmyra and two factories, a vegetable cannery and a beet-sugar factory, at Blissfield.

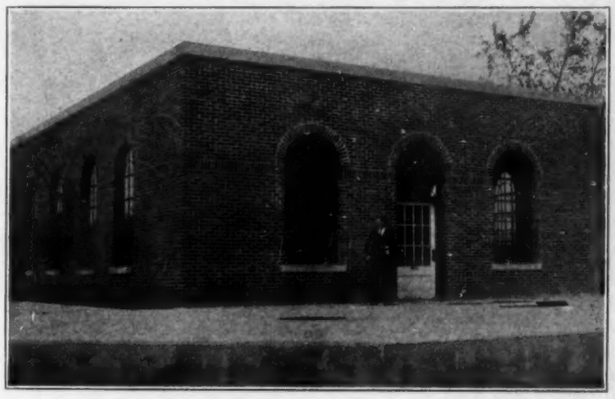
The paper mill wastes give very little trouble, according to information from the Blissfield Filtration Plant, which is located on the River Raisin below the paper mill but above the canning and sugar factories. The distance between the Blissfield and Dundee Filtration Plants is about twenty miles, but considerably further by river. The cannery waste, which has a high oxygen demand value, is delivered to the river in such small quantities as to give no particular taste or odor problem at this plant. This waste may be accountable in part for the higher pre-chlorine requirements during August and September and, no doubt, intensifies the tastes and odors with which we have to contend in the early sugar waste stages, because of the overlapping discharge of the two wastes for a period of about a month. But, because of the high concentrations and the long period over which they extend, it can be said that the major portion of any decided difference in taste and odor problems created between the Blissfield and Dundee Filtration Plants, can justly be traced to the sugar factory wastes, plus the natural and unimportant contamination accumulated by the river in passing through a rural district.



Diagrammatic Arrangement of Units Comprising the Water Purification Plant of Dundee, Mich.

LSP Low Service Pump
A & B Mixing Tanks
C & D Settling Tanks
E & F Carbonation Tanks
G Applied Water Line
H Filters With Clear Water Storage
HSP High Service Pump
K Activated Carbon Pressure Type Unit

That the sugar factory wastes presented a distinct and serious problem in obtaining a palatable plant effluent was recognized by George Champe and Associates, Consulting Engineers of Toledo, O., who designed the Dundee plant. A pressure type filter tank containing a bed of granular activated carbon thirty-six inches deep was included in the plant design. Through this unit the effluent from the rapid sand filters was pumped enroute to the distribution system. The provision of some means of eliminating or controlling the tastes and odors was a very wise one, for at the time the plant was started the river was quite badly polluted by these wastes, making it necessary to throw the carbon filter into operation almost simultaneously with the starting of the plant.



Softening-Filtration Plant, Dundee, Mich.

Every one connected with a water works in 1930 can easily recall that this was a very dry year, resulting in river stages that were below normal. The extraordinary degree of contamination of the River Raisin, during periods of sugar waste flow the first year that the filtration plant was in operation, placed an excessive burden upon the carbon filter which was far beyond anything that had been anticipated at the time of its installation. Especially was this true during the season of Steffens waste dumping, and the duration of the usefulness of the carbon unit was thereby reduced considerably.

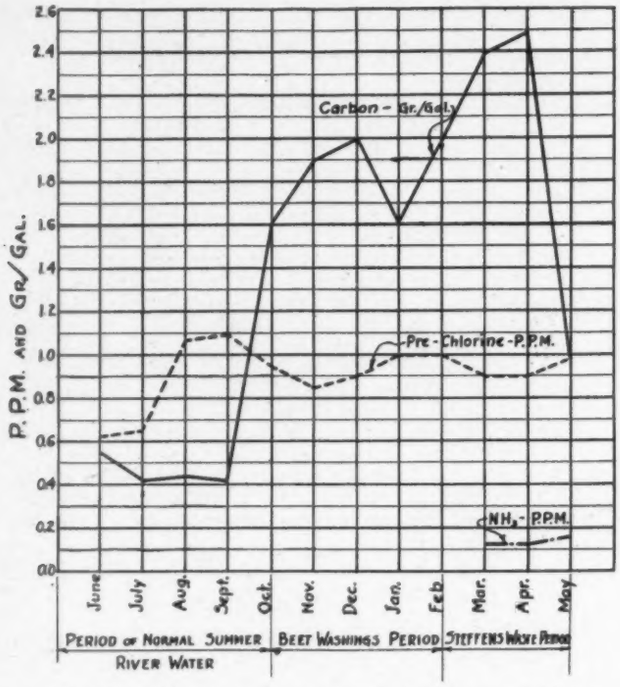
Carbon Unit Fails Under Severe Loading

The records show that the carbon unit removed tastes and odors quite successfully from December, 1930, throughout the sugar waste period of the winter and spring, the normal river of the summer, and the early part of the sugar waste season of the fall of 1931, with the exception of the latter half of April, 1931, when the carbon filter effluent showed decided odors on both the cold and hot tests during periods when the Steffens waste was reaching the intake. The sugar factory pumped a large volume of this concentrated waste into the river in a very short space of time, and to this can be traced the immediate cause of the ultimate failure of the carbon unit.

Further failure of the carbon unit to remove tastes and odors is indicated as early as September 9, 1931, when pre-chlorination was started with the apparent purpose of removing part of the load of organic matter from the carbon filter, thus improving the plant effluent. This was partially successful during the early stages, but failed a short time after the full weight of the sugar wastes reached the filtration plant in early November.

Additional efforts were made during November and December, 1931, and January and February, 1932, to eliminate the tastes and odors, by pre-chlorination and by direct feeding of powdered activated carbon in addi-

tion to the use of the carbon unit. This also was only partially successful, even when as high as 7.0 grains per gallon of the powdered carbon was fed. The failure of this excessively high dosage of powdered carbon was probably due to the use of a carbon of low adsorption value, the high concentration of the sugar wastes, and the impaired condition of the granular carbon in the pressure filter. On March 5, 1932, near or after the end of the sugar waste season, a different brand of powdered activated carbon (Aqua Nuchar) was secured and has been used since, with the results that will be discussed later.



Pre-Chlorine, Carbon and Ammonia Dosages Applied

After the use of the carbon unit had been abandoned and a sample of the granular carbon had been sent to the manufacturers, it was found to have taken up so much organic matter from the sand-filtered water that it could not be reactivated by the use of caustic soda as contemplated, when the installation was made. The firm that supplied the carbon recommended that the granular carbon be packed and shipped to the original manufacturers for reactivation by heat treatment and thereafter the carbon unit be used only in conjunction with heavy pre-chlorination. The Municipal Council has not seen fit, however, to pay the freight charges involved in making the shipment.

A Comparison of Powdered and Granular Carbon

When the carbon filter failed to function properly, the operator turned to direct feeding of powdered activated carbon which practice has the following advantages: First—it gives the operator the means of varying the dosage according to the raw water requirements. This requires vigilance and good judgment which, if exercised, should result in economical operation. Second—it requires inexpensive feeding apparatus and, in fact, home-made equipment can be used. Third—the operator can apply the carbon at the point where he finds it most effective, such as the first mixing chamber, on the filters, at any intermediate point or at more than one point.

The fixed carbon bed has the advantage of being automatic in its removal of tastes and odors and requires very little supervision while working properly. It has the disadvantage of requiring extra power to pump the water for washing the carbon filter bed. With the carbon filter set-up, a duplicate unit with its additional installation cost is almost a necessity, to provide means of treating the water during the washing and revivification periods. In lieu of an extra unit an extra supply of carbon may serve the purpose. Superchlorination, in conjunction with the carbon bed, besides oxidizing a great deal of the organic matter, thus relieving the carbon unit of excessive loads of this nature, also would have the beneficial effect of eliminating gas-forming and other bacteria from the bed itself and prevention of decomposition of any organic matter adsorbed by the carbon.

The sugar wastes arrive about October 1st and continue until about June 1st. They are of two distinct kinds: washings from the beets and slicings and the Steffens waste. Both of these wastes are highly sensitive to chlorine in the usual amounts applied in water works practice, giving a distinct and disagreeable taste and odor which varies from a sweetish beet odor to a putrid straw odor. The hot-odor test on the raw water gives a characteristic sweetish odor of cooking beets when the washings are present and an odor of foul domestic sewage when the Steffens waste is present. Tastes created by both wastes are less objectionable when employing superchlorination, as determined in the laboratory by the writer, the firm supplying the carbon filter and others. Chloramine treatment is also beneficial. Pre-ammonia and pre-chlorine treatment alone does not eliminate these odors from the finished waters. They are, however, almost entirely eliminated in the concentrations that existed during the past year, when powdered activated carbon was used in the proper amount in conjunction with ammonia-chlorine treatment.

Results from the Use of Powdered Carbon With Prechlorination

During the past sugar waste season, the washings were returned to the river at the rate of about 2 m.g.d. beginning September 15th and extending to December 27th. Perhaps, because of their larger volume and the lack of ammonia treatment, this waste constituted a very difficult problem to handle, as indicated by the "hot-odor" tests which frequently revealed a distinct beet odor in the finished water. However, tastes and odors were not noticeable in the cold finished water. About the time the washings stopped, dumping of the Steffens waste from the sugar factory ponds, where it is stored awaiting high water in the river, was started. This very

Chemical Feeders, Filter Plant, Dundee, Mich.

TABLE I—CARBON, PRE-CHLORINE AND AMMONIA APPLICATION DURING THE YEAR JUNE, 1932, TO JUNE, 1933

Chemical Treatment	June	July	Aug.	Sept.	Ave.
	Period of Normal Summer River Water				
Carbon gr./gal.....	.56	.42	.44	.42	.46
Chlorine p.p.m.....	.62	.65	1.06	1.09	.85
Ammonia NH_3 p.p.m..	0	0	0	0	0
	Beet Washings Period				
	Oct.	Nov.	Dec.	Jan.	Ave.
Carbon gr./gal.....	1.6	1.9	2.0	1.6	1.8
Chlorine p.p.m.....	.95	.85	.90	1.0	.93
Ammonia p.p.m.....	0	0	0	0	0
	Steffens Waste Period				
	Feb.	Mar.	Apr.	May	Ave.
Carbon gr./gal.....	2.0	2.4	2.5	.95	1.96
Chlorine p.p.m.....	1.0	.9	.9	.98	.95
Ammonia p.p.m.....	0	.13	.13	.16	.14

malodorous waste did not give as much trouble as the washings, perhaps because it was delivered at the rate of 100,000 to 160,000 g.d. to the river at high stage. Also, ammonia treatment was employed during most of the Steffens waste period. (See Table I.)

By means of pre-chlorination and the application of powdered activated carbon, a satisfactory effluent with the beet washings was obtained. By means of pre-ammoniation, pre-chlorination and powdered activated carbon, a satisfactory effluent was obtained while receiving the Steffens waste. The carbon was applied in both the first and second mixing chambers. The settling basins are equipped with sludge removal piping. The condition of the sludge as to odor and frothiness upon removal at the end of each day's operation was taken as a rough guide for subsequent carbon treatment. Pre-ammoniation was accomplished with a solution of ammonium sulphate applied in the first mixing chamber. Pre-chlorination was carried out by means of a solution of calcium hypochlorite applied in the second mixing chamber. The ratio of Cl to NH_3 was maintained at about 7:1.

The cost of the ammonia treatment was very slight, being about 10 cents per million gallons at the above ratio. The cost of pre-chlorination, while somewhat increased by the beet wastes, is not considered an actual increase in cost as pre-chlorination is now the standard practice at this plant. At present prices, the powdered activated carbon cost was $134.00 for the past year, whereas, interest and depreciation on the installed cost of the pressure carbon filter would, alone, more than pay the cost of the past year's powdered activated carbon treatment.

In evaluating some of the above comparisons, it should be pointed out again that the carbon unit operated under very abnormal river water conditions, whereas, the river conditions and plant operation were more nearly normal during the past year when powdered activated carbon was used. It is highly probable that the life of the carbon filter unit would have been materially prolonged, had the water that was passed through it been pre-treated with chlorine. Then, too, the consumption of powdered activated carbon would most probably have been greater had the concentrations of the sugar wastes been as great as was the case in 1930 and 1931.

The data presented in Table I indicated that the sugar wastes increased the consumption of powdered carbon more than three times the requirements of the algae-laden summer water. The carbon feed may have been higher than necessary at times, but a palatable plant effluent nearly one hundred per cent of the time and satisfied customers, has justified the expenditure of five cents per month per customer for the powdered activated carbon treatment.

The results of the past year at the Dundee Filtration Plant have led the writer to conclude that powdered activated carbon treatment, supplementing pre-ammoniation and pre-chlorination:

(1) Is economical;
(2) Gives a flexible type of treatment;
(3) Sweetens the settling basin sludge;
(4) Gives all year round treatment, if needed; and,
(5) Practically completely removes the objectionable tastes and odors in water containing beet-sugar factory wastes.

NOTES AND REFERENCES

(1) "Water Softening and Purification Plant of Dundee, Michigan," by C. S. Finkbeiner, WATER WORKS AND SEWERAGE, February, 1931, Vol. LXXVIII, No. 2.

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Association Meetings Scheduled

March 1-3—**Kentucky-Tennessee Section A. W. W. A.** Knoxville, Tenn. Secretary, F. C. Dugan, State Department of Health, Louisville, Ky.

March 7-8—**4 States Section A. W. W. A.** Hotel Adelphia, Philadelphia, Pa. Theodore V. Wood, Acting Secretary, Leadite Company, Girard Trust Building, Philadelphia, Pa. (Special attraction-trip through recently completed Franklin Institute Museum and the Fels Planetorium.)

March 24—**New Jersey Sewage Works Association.** Hotel Hildebrecht, Trenton, N. J. Secretary, John R. Downes, Bound Brook, N. J.

April 4-6—**Canadian Section A. W. W. A.** Hotel Royal York, Toronto, Ont., Canada. Secretary, A. E. Berry, Ontario Dpartment of Health, Toronto, Can.

April 10-12—**Southwestern Section A. W. W. A.** Partridge Inn, Augusta, Ga. Secretary, W. H. Weir, State Board of Health, Atlanta, Ga.

April 11-13—**Indiana Section A. W. W. A.** Memorial Union Bldg., Purdue University, Lafayette, Ind. Secretary, C. K. Calvert, R. R. 3, Box 976-H, Indianapolis, Ind.

April 20-21—**Montana Section A. W. W. A.** Billings, Mont. Secretary, H. B. Foote, State Board of Health, Helena, Mont. (School for Water Works Operators precedes meeting April 18-19.)

April ....—**New York Section A. W. W. A.** Binghamton, N. Y. Secretary, R. K. Blanchard, Neptune Meter Co., 50 East 42nd Street, New York, N. Y. (date later).

May 10-12—**Pacific Northwest Section A. W. W. A.** Hotel Eugene, Eugene, Ore. Secretary, E. C. Willard, 720 Corbett Bldg., Portland, Ore.

June 4-6—**Annual Convention of American Water Works Association.** Hotel Commodore, New York City. Secretary, B. C. Little, 29 West 39th Street, New York City.

June 15-16—**New York State Sewage Works Association.** Jamestown, N. Y. Secretary, A. S. Bedell, State Department of Health, Albany, N. Y.

June 25-27—**Pennsylvania Water Works Operators Association.** State College, Pa. I. M. Glace, Secretary, State Department of Health, Harrisburg, Pa.

June 27-29—**Pennsylvania Sewage Works Association.** State College, Pa. L. D. Matter, Secretary, State Department of Health, Wilkes-Barre, Pa.

August 23-24—**Central States Section A. W. W. A.** Hotel Windsor, Wheeling, W. Va. Secretary, H. L. Nelson, U. S. Pipe and Foundry Co., 2435 Koppers Bldg. Pittsburgh, Pa.

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The Pittsburgh Award to Dr. Ralph E. Hall

The Pittsburgh Section of the American Chemical Society has selected Dr. Ralph E. Hall, Director, Hall Laboratories, Inc., Pittsburgh, Pa., as the recipient of the 1933 (the first) Pittsburgh Award.

This honor has come to Dr. Hall in recognition of his distinguished service to chemistry, particularly his contributions to the fundamental knowledge of boiler-water reactions and their applications to the practical solution of boiler-water problems; his discoveries and technical accomplishments in the beneficiation and conditioning of water for industrial and domestic use, and his developments in the production of chemicals for these purposes.

The Pittsburgh Award is represented by an especially designed plaque of gold, on which the relation of chemistry to industry is symbolized artistically.

RECORDING DEPTH GAUGE WARNS OF INTAKE TROUBLES

By CARL LEIPOLD

Superintendent of Filtration, Winnetka, Ill.

ANCHOR ice, plant growths, sand and other material which obstruct water flow through intakes and intake strainers, are indicated by a recording depth gauge installed on a walkway in the intake well, at the Winnetka water plant. The maximum water levels, above and below the center-line of the intake pipe, shown on the 24-hour chart (Fig. 3) are recorded on a monthly report sheet. Unusual conditions shown by variable water levels are noted and explained on the gauge chart.

The water supply of Winnetka is taken from Lake Michigan through two cast iron intakes, one of which

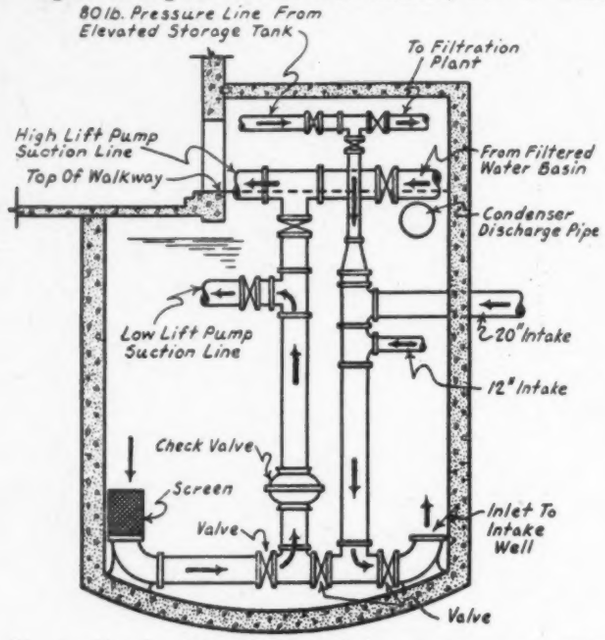

Fig. 1—Sketch of Intake Well Piping Arrangements, Winnetka, Ill., Water Works

is 20 inches in diameter and extends 3,000 feet into the lake and the other is 12 inches in diameter and is 2,200 feet in length. An emergency intake strainer is connected to the 20-inch intake at a point 1,000 feet from shore.

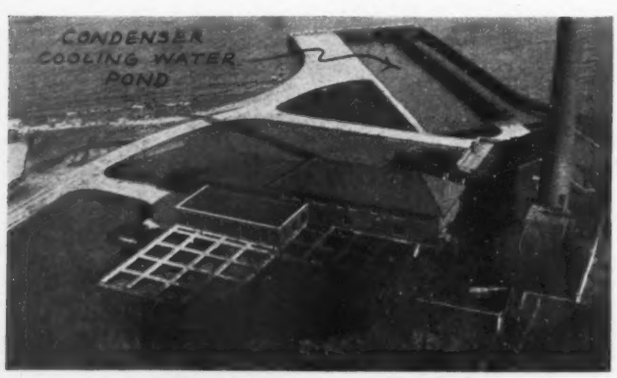

Fig. 2—View of the Filtration Plant Showing Cooling Water Pond Used for Turbine Condenser

The intake well piping (Fig. 1) is assembled to allow filtered water from an elevated storage tank to be applied under 80 lbs. pressure directly to the intake pipes. Also the condenser cooling pond water (Fig. 2) from the power plant recirculating pump can be discharged into the intake well. With these connections, a pressure can be applied from the outlet end or intake well to the inlet end or intake strainers. Also the water level in the intake well can be brought higher than lake level. This arrangement has served favorably for eliminating the usual intake and intake strainer troubles, especially ice troubles.

Fig. 3—the water level chart—shows how anchor ice obstructing the water flow through the intake was eliminated on Feb. 16, 1933. The operator was aware from the chart record that anchor ice on intake strainers started shortly after 2 a. m., with the low lift pump oper-

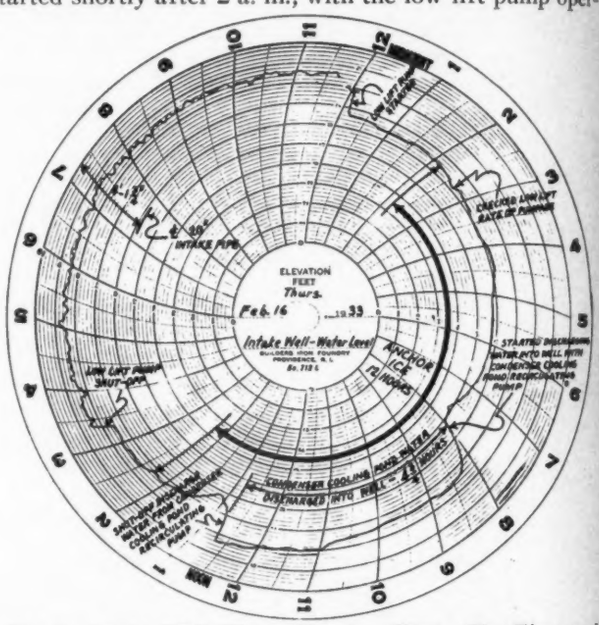

Fig. 3—Intake Well Water Elevator Chart. The Time and the Method Employed to Eliminate Anchor Ice on Intake Strainers Are Indicated

ating at 2.5 M.G.D. rate. The low lift pump rate of pumpage was then throttled to 2.0 M.G.D. but proved to be of no assistance in eliminating the anchor ice on the strainers. At 8 p. m. with the water level dropping rapidly, the condenser cooling pond recirculating pump was regulated to discharge water at a rate of approximately 2.0 M.G.D. into the intake well. After a period of two hours, the chart indicated anchor ice troubles were being relieved and at 12:30 p. m. indicated that the anchor ice had loosened from the strainers.

This method of chart records of water levels in intake wells has proven to be of much value as a warning to prepare for intake troubles, and the taking of measures necessary to eliminate them. The chart record also serves as an indicator of existing operating conditions when making intake capacity tests in the spring of each year following rough lake conditions.

FLOW DIAGRAMS FOR THE CHEMICAL TREATMENT AND FILTRATION OF WATER

By JOHN R. BAYLIS

Associate Editor

TO treat water in a filtration or softening plant so as to make it clear, pure, palatable, and most suitable for domestic uses may involve a number of steps and the use of several kinds of chemicals. All waters are not alike and the procedure which gives the best results in one plant may not be the best for some other water. This article will show several typical flow diagrams with points of application of the several chemicals which are used to treat the water.

It is known that there are many plants in which the flow deviates from the diagrams shown, but it is believed that the diagrams show the method of treatment used in decidedly the majority of the plants. The Census of Municipal Water Filtration Plants for 1930-31, recently published by the American Water Works Association, shows that in over 90 per cent of the rapid sand filtration plants the chemically treated water is passed through a mixing basin, settling basins, and sand filters. Practically all plants use more than one chemical, and some plants now use six or seven different kinds of chemicals in their treatment process.

Flow Diagram for Water Coagulated With Aluminum Sulfate.—Figure 1 shows a flow diagram typical of that of many filtration plants throughout the country in which aluminum sulfate is used to coagulate the water. In the diagram it is assumed that powdered activated carbon is used to remove objectionable tastes. Ammonia and chlorine are used for sterilization, and lime or soda is used for treating the water to prevent corrosion. It should be evident that such plants are not laid out in a straight line as shown by the diagram, but it is believed that the different steps in the treatment can be illustrated better in this manner than to use a typical layout of such a plant.

The water from the source of supply may or may not have to be pumped to the filter plant, and the low-lift pumping station may have been omitted from the diagram, except there are a few instances where the coagulant is added to the water on the suction side of the pumps. The pumps help to give rapid mixing of the chemical with the water, but where there is adequate mixing in the filtration plant little or nothing is gained by adding the coagulant to the water before it passes through the pumps. The pumping station forcing the water to the filtration plant is usually referred to as the low-lift station to distinguish it from the main pumping station which forces the water through the distribution system in the city. Also the head pumped against is usually much less than that of the main pumps.

All plants using a coagulant of some kind should have a mixing basin, or a place where the chemicals are mixed with the water. It is true that the period of mixing in some plants is quite short, and the only agitation the water receives in a few plants is what takes place in a pipe line or conduit leading to the settling basins. This, in some instances, is not over one minute, though the period of mixing is usually much longer. The value of fairly long mixing is now generally recognized and it is not likely that plants in the future will be designed without a special chamber of some kind in which effective flocculation takes place after the coagulant has been added. The mixing basin may be a long pipe line or conduit where the distance between the point of applying the chemicals and the settling basins is long enough for flocculation to take place, but it usually is a specially constructed basin where the water is kept in the desired state of motion either by gravity flow around baffles or by mechanical agitators.

The heavy lines in the flow diagram lead to the points where the chemicals are added in most plants using this kind of a treatment, or at least where it is believed they should be added in the majority of such plants. The lighter lines lead to points where the chemicals are applied occasionally. Some of the plants may apply chemicals constantly at the points shown by the light lines, and others apply at such points occasionally to meet some special condition such as an insufficient application at the main point. If water is found going to the filters improperly coagulated due to insufficient chemical application in the mixing basin, it may be possible by adding additional coagulant to the water at some later point in the plant to avoid a material amount of cloudy water passing the filters. Where no provision for applying the coagulant at points between the mixing basin and filters has been made, all of the improperly treated water will have to pass through the filters, and may result in the water not filtering clear for a period of several hours.

It probably would not be economical nor desirable to add part of the coagulant to the water just before it goes to the filters as a regular procedure, but one is justified in doing most anything for a short period, re-

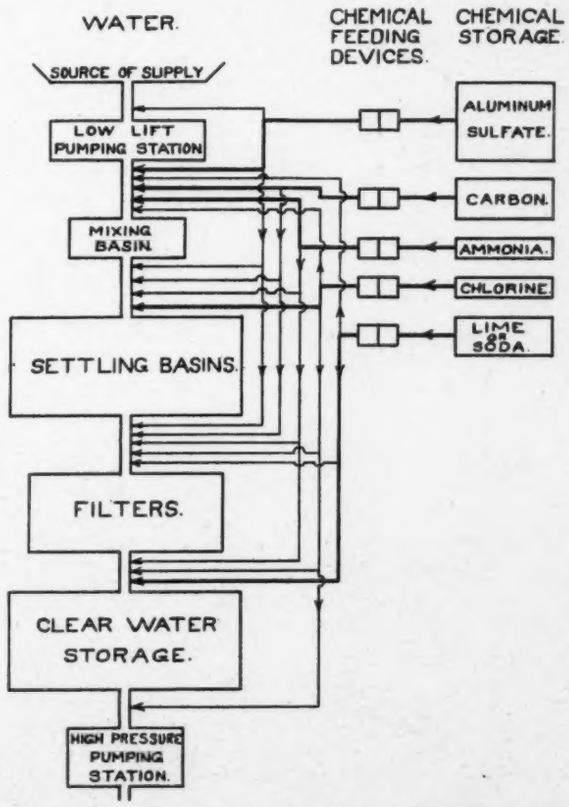

Fig. 1—Flow Diagram for Aluminum Sulfate Treatment

gardless of cost, to prevent cloudy water getting into the distribution system. Each chemical used should have at least one point of application provided beyond the point where it is expected to apply the chemical regularly, with the possible exception of the application of the alkali to reduce the corrosiveness of the water. There will be no serious consequence resulting from an under-application of the alkali for a few hours.

A number of plants do not use all of the chemicals shown on the diagram on Figure 1, and in some instances where one chemical is not used the most desirable point of applying some other chemical may be at a point other than that shown by the chart. If ammonia is not used, the most desirable point of applying the chlorine in many plants will be after filtration. When ammonia is used, the most desirable point, as shown by the diagram, is to apply the chlorine at the entrance to the settling basin or near the outlet of the mixing basin. It of course should be uniformly mixed with the water before the water becomes quiet in the settling basins.

The use of lime or soda, as shown in the chart, is for reducing the corrosiveness of the water, and it is assumed that there is enough natural alkalinity in the water to react with the coagulant. Where there is a deficiency it is necessary to add some alkali before or shortly after application of the coagulant. In this case the heavy lime from the lime or soda feeding device should be shown going to both the mixing basin and to the filter effluent, for in most such cases where aluminum sulfate is used it will be best to add only enough alkali in the mixing basin to react with the coagulant. The additional alkali required for reducing the corrosiveness of the water usually can be applied most economically to the filtered water.

The design of filtration plants in which aluminum sulfate is to be used for coagulating the water and chlorine for sterilization should make provisions for all of the chemicals shown in the diagram in Figure 1, even though it may be thought at the time the design is made that there be no need for removing objectionable tastes and odors and treating the water to prevent corrosion. The chemical feed line shown going to the suction of the low-lift pumps may be omitted if a good mixing basin is designed, but all other connections should be made. A few dollars spent for providing flexibility in the application of chemicals to the water is money well invested.

Flow Diagram for Water Treated With Lime and Ferrous Sulfate.—The flow diagram for water treated with lime and ferrous sulfate is very much like the flow diagram for water treated with aluminum sulfate. The same provision should be made for activated carbon and for ammonia as was shown for aluminum sulfate. The diagram in Figure 2 is intended for waters in which the treatment is primarily for clarification and not for softening. The flow diagram for softening plants will be discussed in another paragraph. The lines leading from the lime and the ferrous sulfate feeding devices to the mixing basin indicate that provisions should be made for applying secondary doses of these chemicals at some point in the mixing basin after application of the main dosage. The main dosage, as shown, should be applied at or near the entrance to the mixing basin. Fairly long periods of mixing are usually provided where the lime and iron treatment is used, and the careful operator will detect deficiencies in chemicals before the water passes through the mixing basin. A deficiency in alkali can be detected by tests very shortly after the alkali has been mixed uniformly with the water, and provision should be made for adding a secondary dose at some point in the mixing basin beyond the point of main application.

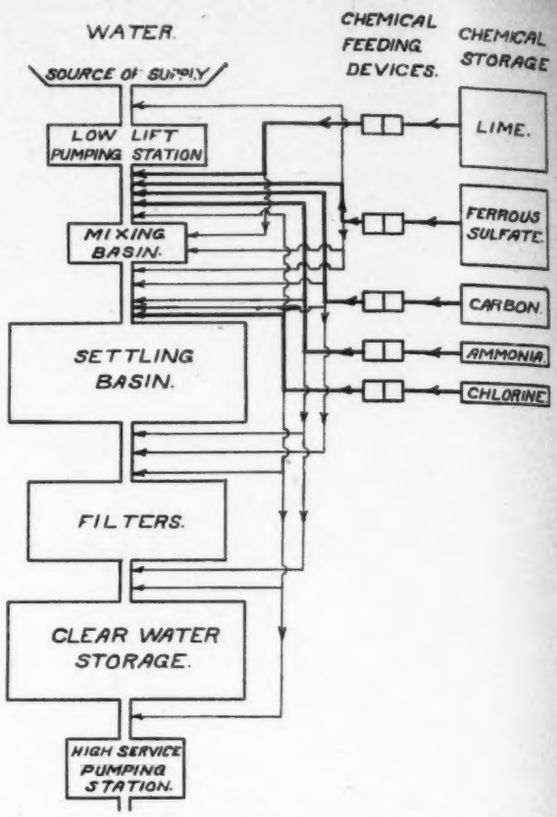

Fig. 2—Flow Diagram for Lime and Ferrous Sulfate Treatment

It will be noted from the diagram in Fig. 2 that the heavy lines for all of the chemicals except chlorine go to the entrance to the mixing basin. There should be sufficient distance between the points of application so that there is fairly good mixing of one chemical before the next chemical is added. The lines show that lime should be applied first, ferrous sulfate second, carbon third, and ammonia fourth. This is a very good procedure, but approximately the same results would be obtained if the order of application was reversed, or if any one of the chemicals was applied first, second, third, or fourth. With the exception of ammonia each chemical should follow as closely after each other as will give time for fairly uniform mixing before the next one is added.

The application of ferrous sulfate is not recommended beyond the effluent of the mixing basin, even for correcting a deficiency of the iron for proper coagulation. This is due to the danger of iron passing through the filters if applied later in the treatment. There are a few plants in which ferrous sulfate may be applied later, but such plants have additional mixing and settling so as to bring about flocculation and some settling of the precipitate before the water reaches the filters.

Chlorinated Ferrous Sulfate.—The flow diagram for water treated with chlorinated ferrous sulfate is so near the same as that for aluminum sulfate that the same diagram may be used. When ammonia is used it should be added to the water, in most instances, before the chlorinated iron is added. The alkali for reducing the corrosiveness of the water may be added at most any point in the plant, though it is thought that there is some advantage in not adding it before filtration in some of the soft colored waters. The reaction between the chlorine and the ferrous sulfate should be complete before the solution containing these chemicals reaches the water to be treated. This reaction is believed to be rapid and probably is completed within a few seconds, though it is

advisable to have a period of approximately one minute after the ferrous sulfate and chlorine solutions have been mixed before the solution is applied to the water. By the addition of an excess of chlorine to the iron solution enough chlorine may be added in this manner to sterilize the water. The chlorine which unites with the iron is no longer available for sterilization. It is believed best, however, to rely upon subsequent chlorination for sterilization.

Ferric Chloride and Ferric Sulfate.—The diagram for aluminum sulfate shown in Fig. 1 is suitable for ferric chloride and also for ferric sulfate. The application of an alkali to reduce the corrosiveness of the water may be applied at most any point in the plant for most waters, though there will be some waters where alkali will be needed to react with the coagulant.

Flow Diagram for a Softening Plant.—The flow diagram for a water softening plant is more complicated than is the case when the treatment is merely for clarification. The diagram shown in Fig. 3 is typical of the plant layout where the water is treated with lime and soda, and where the water contains sufficient magnesium to justify treating to remove part or most of the magnesium. The low-lift pumping station shown in the other diagrams is omitted, not because such stations are not required in many plants but because the water usually is not treated with any of the chemicals before it reaches the treatment plant.

The lime and soda are added to the water at the entrance to the mixing basin. There is no need to wait until the lime or soda has mixed with the water before adding the other one. Due to the difficulty in adding lime at a uniform rate, provisions should be made for adding a secondary dose of lime somewhere in the mixing basin in case insufficient lime is added at the entrance to the mixing basin. It also is well to make provisions for adding additional soda somewhere in the mixing basin. In addition to this, provisions should be made for adding a secondary dose of both lime and soda in the carbonation and secondary mixing basin. This in case there is considerable under-application of lime in the first mixing basin. Enough lime, however, should not be added at this point to precipitate the magnesium unless there is some place where the excess caustic alkalinity can be carbonated and settled after the magnesium hydroxide has settled out of the water.

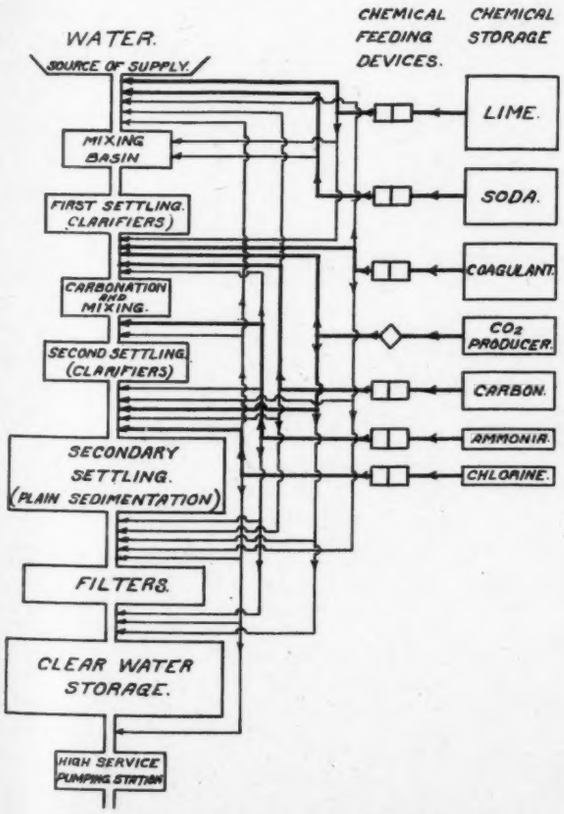

Fig. 3—Flow Diagram for a Softening Plant

It is difficult to state where the coagulant should be added to the water in a softening plant, for different conditions and characteristics of the water will influence the results. Where there is considerable magnesium an excellent coagulation is produced by increasing the pH to about 10.5 to 10.8. A precipitate of magnesium aluminate may be produced when the pH is above about 10.0 when aluminum sulfate or sodium aluminate is used in the treatment. It frequently is desirable to add some of the coagulant in the first part of the mixing basin near where the lime and soda are added. In some softening plants it is advisable to add a little coagulant just before the water goes to the filters. To provide for most any condition in the layout of the coagulant feed lines it is well to provide for the addition of the coagulant in the first mixing basin, the carbonation and secondary mixing chamber, the inlet to the plain sedimentation basin, and the outlet of the plain sedimentation basin just before the water goes to the filters. Where the water is very turbid and does not contain much magnesium, a coagulant likely will be necessary to effectively precipitate the turbidity. Aluminum sulfate, sodium aluminate, or any of the iron compounds commonly used in coagulating water may be used. The iron probably does not combine with magnesium, but ferric hydroxide is easily precipitated when the water is quite alkaline.

The several kinds of chemicals and the various points of application of the chemicals in a softening plant show that the water undergoes extensive treatment before it is ready to be delivered to the distribution system. Enough soda in the form of sodium carbonate should be added to unite with the sulfate and chloride which is in combination with calcium and magnesium, and enough lime should be added to convert all of the calcium bicarbonate to calcium carbonate and to have sufficient calcium hydroxide to cause precipitation of magnesium as magnesium hydroxide. This usually requires a pH of about 10.5 to 10.8, which means that there must be from 25 to 40 p.p.m. of caustic alkalinity. Where there is over about 10 p.p.m. of Mg in the water, a heavy gelatinous precipitate will be formed which entraps practically all of the calcium carbonate particles and other particles of suspended matter. In other words, the water is coagulated with magnesium hydroxide produced by converting the magnesium originally in the water to magnesium hydroxide. This form of magnesium is very insoluble.

The water after the treatment just mentioned then should be passed into settling basins provided with continuous sludge-removing devices. Most of the heavy precipitate will settle out in these basins. After primary sedimentation to remove the larger portion of magnesium hydroxide the water should be passed through a chamber where it is carbonated to the extent that only about four or five p.p.m. of caustic alkalinity remains. There should be sufficient mixing in this chamber to bring about the formation of a good precipitate of calcium carbonate. The water might then go to the plain settling basin, but it is preferable to run it through other basins provided with continuous sludge-removing devices before it goes to the plain settling basins. The sludge from the secondary clarifiers may with profit be returned to the water at the entrance to the first settling basins. This aids in

rapidly building up a good precipitate in the first mixing basin. The water after sedimentation then should be carbonated to the extent that it is approximately saturated or very slightly supersaturated with calcium carbonate just before or just after filtration.

Two main points of applying carbon dioxide are shown in Fig. 3. This is desirable where the water is treated with lime or caustic soda to excess so as to precipitate magnesium. If the water in the first treatment is treated to the extent that there is only about five to ten p.p.m. of caustic alkalinity, the first carbonation chamber and secondary settling basins with sludge-removing devices may be omitted. Then the plant would consist of a mixing basin, a settling period with continuous sludge removal, plain settling basins, and a carbonation chamber just before or just after filtration. This is along the lines of softening plants constructed years ago before beginning of the use of carbon dioxide. Such plants, however, do not give as good softening as the plants where the water is treated with an excess of lime, though it may be the most economical arrangement.

Activated Carbon.—All water purification plants handling surface water should be provided for the use of activated carbon for taste and odor removal. At present, the most extensive use of activated carbon is in the powdered form where it is applied to the water and removed by sedimentation and filtration. Where very small quantities are used it may be applied directly to the filters, but usually it will be necessary to apply it at some other point in the plant. Where the water is treated with a coagulant for the removal of suspended matter, a very good plan is to add carbon to the water in the mixing basin near where the coagulant is added. Figs. 1 and 2 show that the most desirable point for applying powdered activated carbon, where the water is not softened, is in the mixing basin. In addition to this, at least one other line should be run so as to feed carbon to the water just before it goes to the filters. If the settling is in two stages another line should be run so that carbon may be applied where the water goes from one settling basin to the other one. Due to the heavy precipitate produced in softening plants it probably is more desirable to add that carbon after some of the precipitate has settled. Practice in such plants vary considerably, and while good results are reported where the carbon is added in the first mixing basin, it is believed better to add it as shown by the heavy line in Fig. 3, if this type of treatment is used.

Ammonia and Chlorine.—In all of the illustrations, both ammonia and chlorine are shown. Ammonia will not be necessary in all of the plants, but it should be used in most instances. The ammonia should be added sufficiently in advance of the chlorine to insure fairly uniform mixing with the water before the chlorine is added. It may be desirable to add some chlorine in the beginning of the treatment process in some plants, then add ammonia and chlorine after filtration. Usually when this kind of treatment is used only enough chlorine is added in the mixing basin so that no residual chlorine will pass through the filters. Where there is considerable pollution in the water it is believed that adding the ammonia and chlorine where shown by the heavy lines in the diagrams is the safest procedure. This will give a long time contact of the water and sterilizing agent before the water is delivered to the consumers, and will insure it being properly sterilized if sufficient chlorine is added.

Chemical Feeding Equipment.—This is not a discussion of chemical feeding devices, but it should be well to state that the devices should be capable of accurately proportioning the chemicals. There should be at least two devices for every chemical used, and for the larger plants more than two devices should be provided. Such devices will occasionally need to be out of service for repair or for cleaning off incrusted material, and the capacity of each device should be large enough to handle the maximum demand for the chemical which is fed through it unless more than two devices are installed. It is believed for plants of 10 to 100 million gallons capacity that at least three chemical feeding devices should be provided for each of the chemicals used regularly, with each device capable of taking care of average demand. For plants of more than 100 million gallons capacity there should be at least 4 chemical feeding devices for each of the main chemicals used, with any two of the devices capable of taking care of maximum demand.

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Darwin W. Townsend Enters Consulting Engineering Practice

We learn of the resignation of Darwin W. Townsend as Acting Chief Engineer of the Milwaukee and Metropolitan Sewerage Commissions, in order that he might devote his whole time to consulting engineering practice. Mr. Townsend announces that he has entered the firm of Consoer, Older and Quinlan, 205 W. Wacker Drive, Chicago. He has also been retained by the Milwaukee and Metropolitan Sewerage Commissions to serve them as Consulting Engineer.

Mr. Townsend's experience in the water works and sewerage field dates back to 1910 when he entered the employ of T. Chalkey Hatton at Wilmington, Del. Since 1914 he has been Engineer of Design, then Principal Assistant Engineer and finally Acting Chief Engineer of the Milwaukee and Metropolitan Sewerage Commissions. Since 1930 he has been affiliated with the firm he now enters and has served as Consultant on important sewerage and sewage treatment projects including the Wards Island, N. Y., and Cleveland, O., projects. Mr. Townsend is also the inventor of equipment used in sewage treatment plants and has performed other pioneer work in the field.

In his new undertaking we wish him every success.

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Captions Interchanged Under Illustrations in Our December Issue

Two of the illustrations accompanying the article "Methods for the Aeration of Sewage," by Professor H. E. Babbitt which appeared on pages 27 to 30 in our December issue, had their captions interchanged. The whirling horizontal aerator head is the Simplex device at Monroe, Wis., and the long paddle-like agitator is the Link Belt device. We have had numerous readers call this interchange to our attention and therefore to make it clear to those not appreciating the error we are glad to make the correction.

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STREAM POLLUTION REMOVAL IN ILLINOIS—Progress made in removing stream pollution in various sections of Illinois during the past year were discussed at the first regular 1934 meeting of the state sanitary board on Feb. 4. Dr. Frank J. Jirka, director of the department of public health, was re-elected chairman, and Harry F. Ferguson, chief sanitary engineer of the department, was renamed technical secretary. The board will meet again Feb. 27 to discuss plans further and to act on projects already started. Officials of Lincoln, Belleville, Litchfield and other cities possibly will be called in to report improvements made by order of the board.

EDITORIALS

Code of the Water Supply Industry

A CODE of Fair Competition and Regulation for the Water Supply Industry has been completed by the Institute of Water Supply Utilities, Inc., and submitted, for final approval, to the Administrator of the National Industrial Recovery Act. The Institute of Water Supply Utilities, Inc., is an organization composed of corporations and individuals owning or operating water supply facilities and water works plants in America. It is patterned, in general, after other Associations and Institutes set up to regulate trade practices and competition and otherwise function for the good of the industry represented. After a fashion, such trade groups might be considered to be regulated trusts, which attempt to remove unfair competition, eliminate wasteful practices, and maintain equitable and balanced production and marketing—but avoiding outright price-fixing or otherwise running into conflict with the anti-trust (Sherman) Act. The value to industry of Trade Associations and Institutes was seen by ex-President Hoover while Secretary of Commerce and encouraged by the Department of Commerce then and, further so, during Mr. Hoover's term as President. Now, in drafting of the many Codes, these useful organizations have become essential and the work of the Administrators of the N. R. A. would have been simplified, far smoother and swifter had there been more of these trade groups in harness earlier. We might go so far as to say that the depression would have been far less severe, and probably ended long since, had industry generally been regulated through Trade Associations or Institutes manned by strong executive boards, empowered to effect consolidations, reduce over-production. Thus, these organizations might have snuffed out the spark of wasteful cut-throat competiton before it had a chance to burst into the flame that started a conflagration which threatened the solvency of the Nation.

Little, however, by comparison with other enterprise, did the water supply industry feel the dagger thrust of destructive competition and not until regulation by the NRA appeared imminent, did it feel the real necessity of organizing for the best interests of the industry. There are many benefits to be expected as an outcome of the setting up of the Institute of Water Supply Utilities and the organization may be expected to continue with good effect far beyond the period of the NRA Code. Some of the high lights of interest in the Code of the Institute as it now stands are worthy of review and comment.

Finding it impractical to bring municipally owned and operated water utilities under the regulations of the Code, this class is expected to comply only upon "voluntary participation by such . . . . publicly operated plants . . . . as specifically obligate themselves to put into effect any or all of the provisions of this Code." To this reviewer, the lack of regulation and loss of opportunity to divorce from political manipulation or financial starvation, by shortsighted officials, this most important of municipal utilities, is regrettable—in fact lamentable. Furthermore, while the working man and operators employed by private water utilities are taken care of by the Code, his brother worker who has had lean years of income in the same industry, municipally controlled, must continue, in many cases, to stand 12-hour shifts and a double-shift once a week to get a 12-hour "day off"—all without assurance of even the minimum wage set by the Code. Even under the Code the water utility of fifth-class communities (population under 2,500) is not limited to hours of work per man, but at least a minimum weekly wage is set at $12.00 with pay, on an hourly rate, at a 30-cent minimum.

In no instance do professional workers—engineers, chemists or others "in occupations involving special education or training"—come under the regulations of the Code. But, there is some balm for this class when they are treated not differently from executives and managers or others in supervisory capacities, earning more than twice the applicable minimum rates of pay, i. e., more than $130.00 per month in the largest plants.

In stipulating the hours of work allowed for the average per week, a six-week period is accepted as that in which the average may be computed. The time allowances are practically identical for office and operating employees—starting at 40 hours per week in cities of more than 250,000 and jumping to 48 hours in cities of between 2,500 and 250,000 population. In communities of less than 2,500 the hours are not limited.

There are numerous and varied provisions applicable to special classes of employees, and conditions, under which maximum hours of work do not rigidly apply—such as: during periods of emergencies; to emergency maintenance and repair men; to employees (in cities of less than 250,000 population) in offices, pumping stations or purification plants employing not more than two men (exclusive of managers) on duty at any one time; and, to employees in localities where reliefs are difficult or impracticable. Further, in any pumping station or purification plant, operators and their immediate helpers, if not readily replaceable, may work overtime provided an average of 48 hours per week is not exceeded when computed over any period of 6 consecutive weeks. Collectors, customer service men, complaint and emergency men and others whose hours of work are irregular or whose work involves calling at customers' premises or travelling outside of the community, are classified as being subject to a flexible averaging of hours, upon proof of necessity.

The weekly rates of minimum pay are set at $15.00 in all cities above 500,000 population and drop to between $12.50 and $14.50 in cities of 75,000 to 500,000, the higher rates being fixed for the North, East, Middle Atlantic and Pacific Coast sections. In cities of less than 75,000 population the rates are $12.00 to $13.00 minimum per week. In all sections the hourly rate of pay is set at 40 cents, except that when the going rate for a given class of work was less than that on July 15, 1929, such a minimum is allowed. In all cases the absolute minimum must be, not less than, 30 cents. "Learners," (defined as a novice employee on new work less than 12 months), office boys, working pensioners, janitors and laboratory helpers and the like can be paid at a minimum rate of 80 per cent of the scheduled rates. Reclassification of employees or duties performed by employees, for the purpose of defeating the provisions of the Code, is not allowed.

An interesting feature is the incorporation of a "condition" which allows employers "the right to organize and bargain (with employees) collectively through representatives of their own choosing . . . . for mutual aid protection."

The Code Authority, whose duty it will be to see that the Code is lived up to and that of making and recom-

mending of changes, "shall consist of 9 members or such greater number as may be proposed by the Code Authority." The apportionment of members of this Authority shall be such that it consist of one member, or more, representing the Water Supply Utilities Institute; one or more representing privately owned and operated water utilities, that are non-members of the Institute; and, one or more members representing municipal, State or Federal operated water utilities which shall have subscribed to the Code. In addition there may be appointed by the Administrator of the NRA three (non-voting) members as representatives of the public—to serve at no expense to the voting members.

Members of the Code Authority are to be apportioned among, and chosen from, subscribers to the Code, "on the basis of the ratio which the total gross revenue for water service during the preceding calendar year, by the members of the Industry *within the class,* is ascertained to bear to the total gross revenue from water service, by *all members* of the Industry represented."

An important authority of this governing body is found in the allowance of recommendation to the Administrator, that any member of the Industry found by it to be, "financially unable to undertake or continue compliance with requirements of the Code, as to minimum wages or maximum hours" be exempted wholly or in part from its provisions.

Under the heading, "Fair Competition," there is an important stipulation concerning unfair competition on the part of municipally operated plants. The Code states—"that where a member of the Industry is subjected to competition, therein, by a plant or enterprise which is not conforming to requirements of the Code, such member shall upon application through the Code Authority, and approval by the Administrator, be equitably exempted from the operation of this Code within the areas affected by such competition."

Modification of the Code may be made, based on experience or change in circumstances, upon petition by members whose sales of water during the preceding year has been at least one-half the total water sold by all subscribing members, during the same period.

Although, it seems unfortunate that all municipal water utilities are not to be compelled to live up to the Code, it is probably well for the members of the Water Supply Utilities Institute that they do not subscribe. If such was the case, it would be a bit one-sided to find that the apportioned membership on the Code Authority might conceivably leave but the minimum stipulated single membership to Institute members, the same to privately owned water utilities not in the Institute, three in the hands of representatives of the public and the other 7 or more memberships (apportioned on the basis of ratio of gross receipts for water to the total receipts of the entire membership) in the hands of New York City, Chicago, Philadelphia, Los Angeles or other large municipally owned water works.

The need for fair practice by privately-owned water utilities was not a factor of consequence in the establishment of the Institute but we believe it will be found of decided value in many other directions, to the water supply industry in years to come.

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Utilitarian Sludge Gas

FOR many years sewage sludge has been digested in tanks. The only real interest exhibited in the evolved gases of putrefaction, until recent years, was that of how far away the sewage works had to be located from a community to prevent odor nuisance, and how wide the gas-vents on Imhoff tanks had to be to overcome frothing over of these gas exits. Then, someone conceived the idea of burning the digestion chamber gases to destroy their odor and later the heat derived by burning was put to such use as creating draughts in covered sludge beds. Only comparatively recently has the gas been burned in incinerators and under boilers used to produce hot water for heating and speeding up separate digestion tanks by recirculating the water through coils within the digesters. Still later, sludge digester gas has been put to the even more profitable use of operating gas-engines to produce power—the heat recovered from the exhaust gas being used to warm the circulation water. Thus almost everything from the gas except the "squeal" may be made of value.

In an article in the December issue of WATER WORKS AND SEWERAGE, we learn of a new use to which digester gas is being put. At Greenwich, Conn., G. E. Griffin, Engineer in Charge of Sewage Plants, has redesigned the burner on a gas fired refrigerator so as to make its operation on sludge gas reliable and a money saving procedure. It is apparent that sludge gas bids fair to become the primary self-supporting element produced in sewage treatment. It is an interesting by-product, that can be utilized to produce power, heat and/or cold at the will of the operator.

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The Value of Awards

TO encourage the production of better papers to be read in meetings, to build up interest in and increase membership of associations and to stimulate improved operation and maintenance of purification plants and treatment works, awards, made by several associations or individual members through such associations, have a decided value.

The California Sewage Works Association has for several years presented a plaque and award to the operator of the Sewage Treatment Works who has been adjudged to have brought about the greatest improvement, during the year, in appearance and operation of the plant over which he has charge.

The New York Sewage Works Association presents annually the Kenneth Allen Award to the author of the most original and interesting paper read during the year previous. And, at its 1933 meeting, the Central States Sewage Works Association announced that an annual presentation of $20.00 in gold would be made each year as an award to the member adjudged to have presented the best paper during the previous year.

In North Carolina, McKean Maffitt, Superintendent of Water Works at Wilmington, N. C., a charter member and Past President of the N. C. Section of the American Water Works Association, is the donor of the Maffitt Membership Cup—this award going each year to that member responsible for bringing in the largest number of new members during the year. Competition for the Maffitt Cup has been responsible to a large measure for the building up of membership in the North Carolina Section. Mr. Maffitt had a fruitful idea and loose purse strings when he established it.

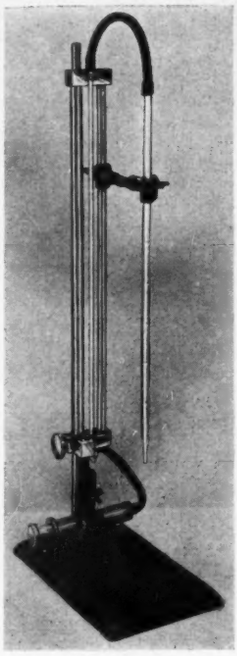
Such awards yield returns which merit consideration by those associations who have not already established such honorary prizes or honorariums.

Leonard.

NEW EQUIPMENT AND MATERIALS

Phipps and Bird Offer Novel Titration Unit

Phipps and Bird, Inc., 915 E. Cary St., Richmond, Va., are offering a novel and practical titration unit in which is involved an ingenious scheme of sensitive and accurate feed control of the solutions used in titrations.



Neale-Forbes Titration Unit

The outfit, pictured here, consists of a support carrying a lubricated syringe at the base, a burette or pipette with rubber and glass tube connections to the syringe. To fill the burette or graduated pipette, the tip is submerged in the solution with syringe plunger pushed in. Pull out the lubricated plunger and the pipette is sucked full of liquid above the zero mark at the top. Push in slowly to lower the meniscus to the zero mark. Titrate by further pushing in the plunger to displace liquid as rapidly or as gently as desired. Splitting drops is no trick with this equipment should it be desired to use strong solutions or a small volume of sample titrated. Interesting is the fact that no burette stop cocks, to stick, break or leak, are used with this equipment; no finger to hold over the end of the pipette; no lost time or samples on account of slips. The plunger action is delicate but positive, but no solution reaches the plunger chamber. The price is attractive. For further information, write Phipps and Bird for their descriptive leaflet, "N-F Titration Unit," and "Superior" standard solutions.

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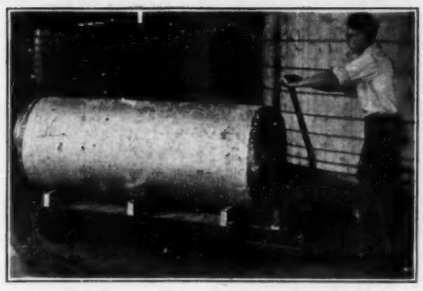
Lift Trucks for Chlorine Containers

The Lewis-Shepard Company, Watertown Station, Boston, Mass., are offering an improved lift truck for handling one ton containers of liquid chlorine at water plants and sewage treatment works.

The truck in its down-position is rolled under the skid platform holding the container. By a simple jacking operation, the truck handle serving as the jack arm, the skid platform and container is raised so as the legs clear the floor. The container on the platform is thereafter easily rolled to any other desired position. The truck is then "jacked down" and removed for further use.



Lift Truck for Chlorine Containers.

When placed on a platform scale the skid platform is left in place and removed with the empty container.

The Lewis-Shepard Company also supply overhead handling equipment for ton containers for use alone or in conjunction with the lift truck.

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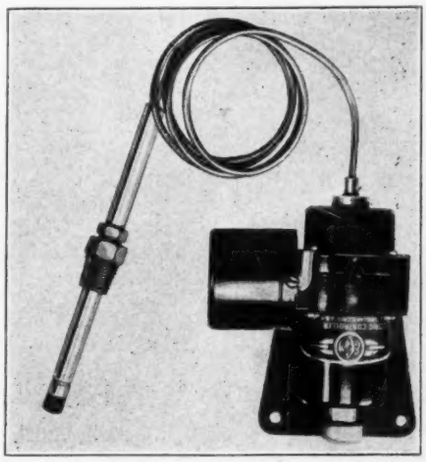
E. C. & M. Bearing Thermostats

Overheated bearings on rotating machinery, motors and pumps in particular, are frequently the cause of damage and loss of money and time.

To prevent such occurrences the Electric Controller and Machinery Company of Cleveland, Ohio, have developed the "E. C. & M. Bearing Thermostat," which has an especial value for use in automatically operated pumping stations. The compact thermostat is of simple but sturdy construction. Any rise of temperature at the bearing expands a volatile liquid contained in a metallic bulb installed in the bearing and connected to a seamless one-piece metallic bellows. The pressure created by the rapidly expanding liquid is transmitted to the bellows which expands and creates a parting of silver contact points and thereby opens the relay to break the current flow to the motor operating the machine. The motor and machine will remain inoperative thereafter until such time as the trouble has been corrected.



E. C. M. Thermostat with Flexible Tubing Attached

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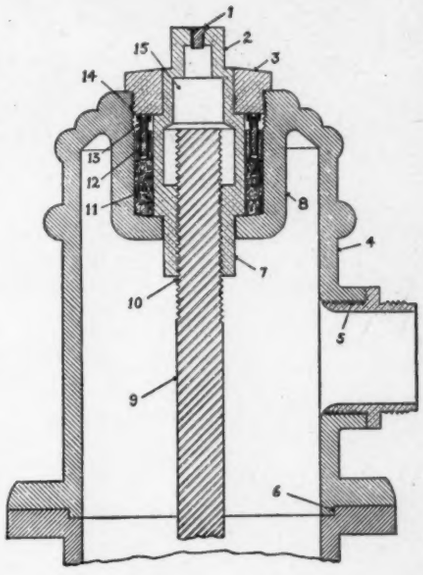
The Crispin Hydrant

Every Crispin Hydrant is built to conform to American Water Works Association specifications, backed by many years of experience in the water works field.

An important feature of the Crispin Hydrant is the bronze packing ring (12) and four adjusting screws shown in the above sectional line drawing. The adjustment screws prevent the left hand threaded bronze nut (3) from compressing the packing too greatly when the nut is screwed all the way down into its recess. To increase the pressure on the packing the screws are backed out by turning each one or two turns.



Cross Section of Head.

No water, sand or grit can work into the threads on the stem because of careful machinery of stem threads and operating nut threads (7). The packing nut can not be loosened when opening the valve. The valve stem is oversized (1¼ inch) making for strength.

The Crispin Hydrant is of the compression type, the water pressure alone keeping the valve closed in case of damage or breakage of the upper part of the hydrant.

For further information address the Multiplex Manufacturing Co., Berwick, Pa.

Improved Gas Meter for Sewage Disposal Plants

The Pittsburgh Equitable Meter Company of Pittsburgh, Penna., have recently announced an improved gas meter for use at sewage treatment plants. After a careful study of various conditions and thoroughly testing in laboratory and field, the company now offers the EMCO Gas Meter, built in several sizes to take care of all volume requirements. All of the features

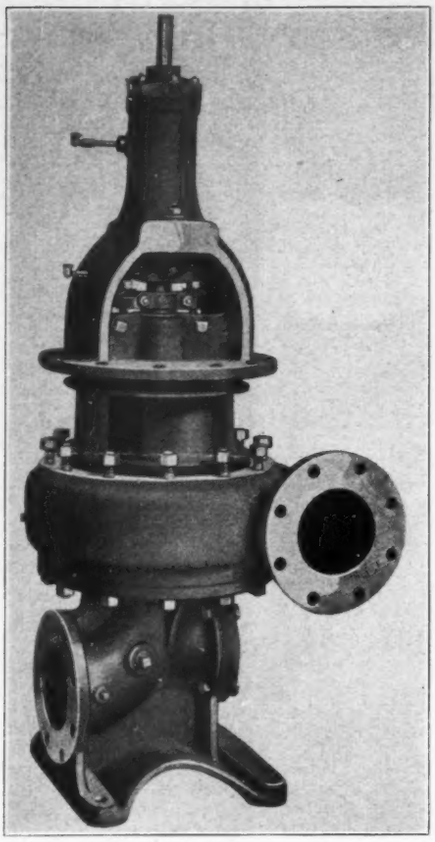
EMCO Sludge Gas Meter

embodied in Standard EMCO meters, produced for some time by the Pittsburgh Equitable Company, plus additional features and improvements required for this particular service, have been incorporated in the EMCO Sludge Gas Meter.

Practically every modern sewage treatment plant is being equipped to collect, measure and burn the gas from sludge digestion tanks. Several convert the gas into power through use of gas engines. The improved EMCO meter is designed to afford an accurate measurement of all of the gas produced and also that converted to heat or power.

Non-Clog Enclosed Impeller Sewage and Trash Pump

Non-clogging crude sewage and trash pumps of the open impeller design are notoriously and necessarily inefficient in power consumption. Believing that the higher efficiency, enclosed type impeller could be designed to serve as satisfactorily as an open impeller, Goulds Pumps, Inc. of Seneca Falls, N. Y. have perfected an enclosed impeller which is being offered in their new line of sewage pumps. Exhaustive tests, they state, have proved that the blunt nosed veins of practically full width, incorporated in the new impeller, have made higher efficiencies in non-clog pumps a practical realization and, therefore, from now on all Goulds pumps will be built with enclosed type impellers and offered in competition with open impeller types. The enclosed type impeller maintains pumping efficiencies because of less effect from wear by gritty substances in sewages. The company claims that, being properly designed, it will



Goulds Enclosed Impeller Vertical Sewage Pump. (Cover Raised to Show Impeller)

pass rags, hair, strings and other solids as effectively as the open type. The new impeller is of bronze or iron (as specified) and is keyed to the shaft and secured by an acorn nut.

The new pumps are available as horizontal or vertical types in capacities of 200 to 5500 g.p.m. (4 to 12 inch discharge). A leaflet, recently issued describes these pumps—write for a copy of "Goulds Sewage Pumps—3120 and 3121." Address Goulds Pumps, Inc., Seneca Falls, N. Y.

WITH THE MANUFACTURERS

L. E. Rein Succeeds S. Fisher Miller as President of Pacific Flush Tank Company—H. E. Schlenz Made Secretary

Mr. S. Fisher Miller, who has occupied the position of President of Pacific Flush Tank Company since December, 1910, has retired from active service and Mr. Lester E. Rein of Chicago who has been Secretary of the Company for the past thirty-three years, was elected to succeed Mr. Miller.

Mr. Harry E. Schlenz, Sales Manager of the Company, has been made Secretary and Director of the Company. The New York office is continued with Mr. Lionel L. Langford as Eastern Manager.

Pacific Flush Tank Company has been continuously in business since 1893 designing and manufacturing sewer and sewage treatment equipment exclusively.

G. H. Cressler Joins Graver Tank and Manufacturing Company

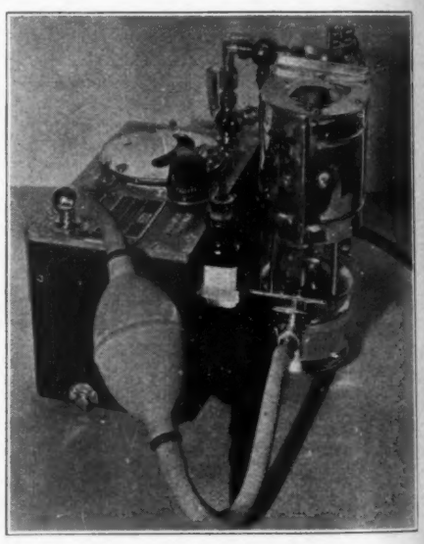
George H. Cressler—former Vice President and General Sales Manager of The Stacey Manufacturing Company and Vice President of the Stacey Brothers Gas Construction Company of Cincinnati, Ohio, has become a member of the organization of the Graver Tank and Manufacturing Corporation.

Mr. Cressler was at one time a member of the firm of Walker and Cressler, Consulting Engineers, Chicago, specializing in Public Utility Engineering, design and construction and later served as an officer in the Ordinance Department of the U. S. Army, in charge of important construction work on the Pacific Coast. Since 1921 he has been Sales Manager of, and later Vice President of, the companies which he leaves to join the Graver Corporation.

All-Service Gas Indicator Announced

The U. C. C. All-Service Gas Indicator is the latest addition to the gas indicating equipment of The Linde Air Products Company, New York, N. Y. It supplements two other indicators, the U. C. C. Methane Detector and the U. C. C. Combustible Gas Indicator.

It does three things: (1) Indicates how flammable or explosive an atmosphere is; (2) shows the presence of poisonous gases



The U. C. C. All Service Gas Indicator

and vapors; and (3) indicates any deficiency of oxygen.

It can be used with absolute safety for testing sewers, pits and manholes; locating underground gas leaks, and in purging operations. Like the earlier instruments it is equipped with a body harness, is simple to operate and is complete and ready for instant use in sewer inspection and testing tanks or pits. Chemical industries should likewise find it of considerable value.

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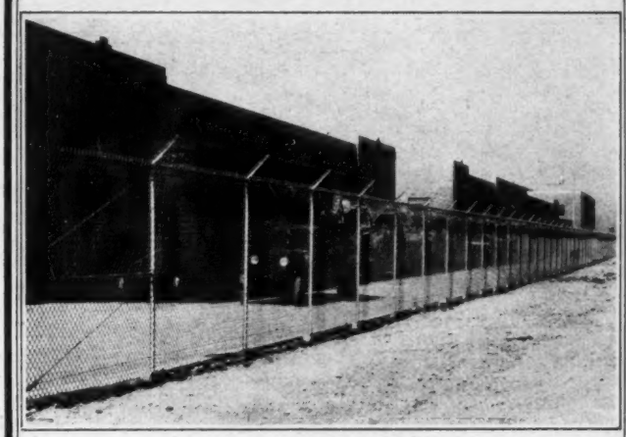

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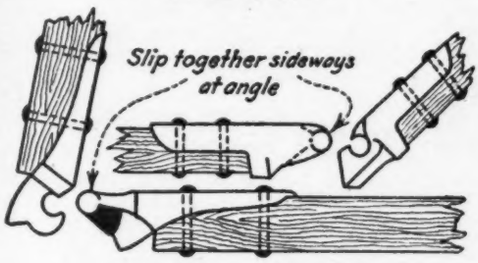

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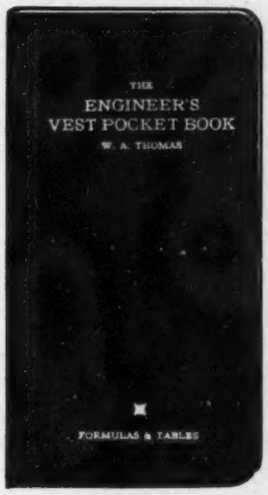

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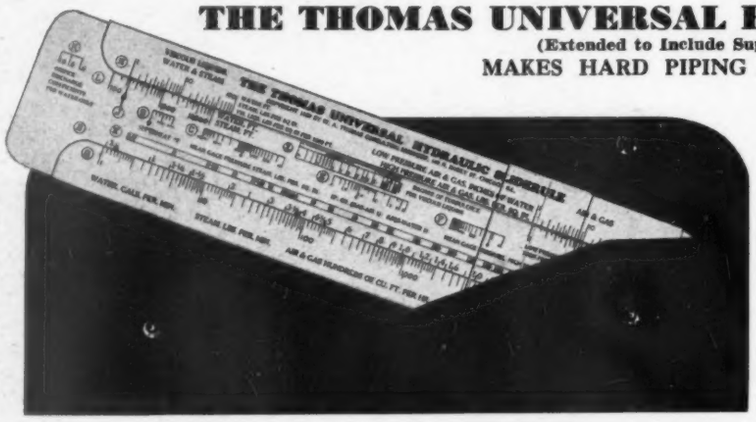

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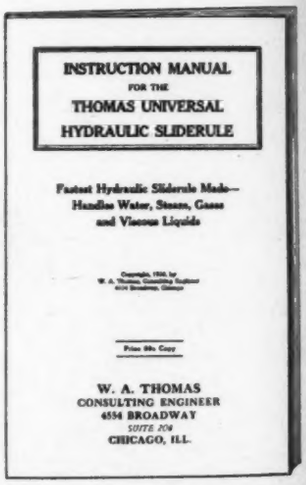

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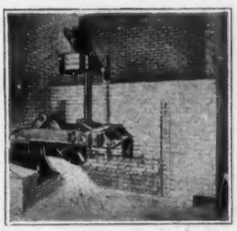

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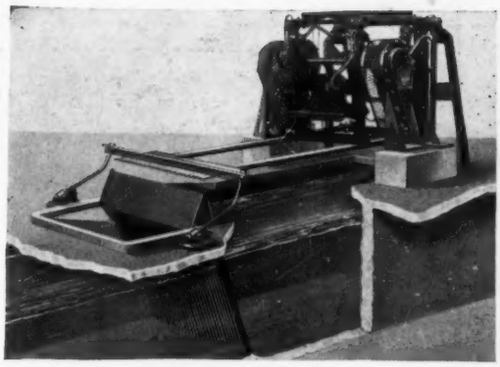
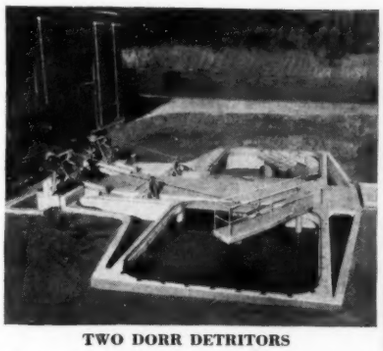
- *A veteran sanitary engineering staff, averaging 10 years in Dorr service*
- *An installed capacity of several billion gallons per day*



THE DORRCO BAR SCREEN

It is more than a coincidence that fifteen years of pioneering has resulted in a complete, proved line of Dorr equipment, adapted to every step, every process.



TWO DORR DETRITORS

THE DORR CLARIFIER

It is more than just a coincidence, that a skilled engineering staff, built up and trained to service each machine from start to finish, averages ten years in our employ.

THE DORR DIGESTER

THE DORRCO DISTRIBUTOR

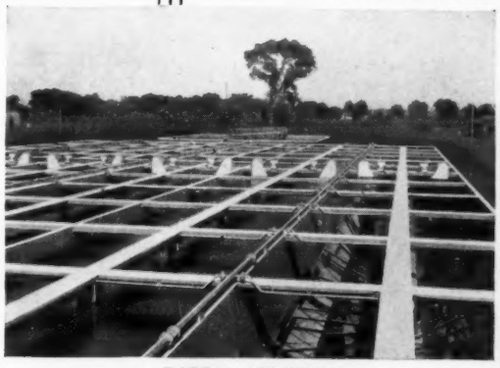
More than a coincidence, too, that the lowest cost activated sludge plant and the lowest cost separate digestion plant in the United States are both completely Dorr equipped.

And it could hardly have been a mere coincidence that Dorr machines and methods are daily entrusted with the treatment of several billion gallons of sewage, water and trade wastes in hundreds of plants in 14 nations of the world.

DORRCO

To the designers and builders of today's modern plants, this Knowledge and Experience is freely available. It adds neither to the shipping weight nor appears on the invoice, yet it is the best possible assurance of long and reliable service.

NRA MEMBER U.S. WE DO OUR PART



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THE DORR COMPANY, INC.

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TORONTO CHICAGO LOS ANGELES DENVER

Affiliated with OLIVER UNITED FILTERS INC. Engineers

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ENGLAND: Dorr-Oliver Company Ltd., London
GERMANY: Dorr-Oliver Gesellschaft, m. b. H. Berlin
FRANCE: Soc. Dorr-Oliver, Paris
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